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THE DISTRIBUTION OF RADIATION IN THE ATOMIC BOMBING OF NAGASAKI

By JOHN C. LARKIN, M.D.

NEW BRITAIN, CONNECTICUT

INTRODUCTION

THE bombing of Nagasaki on Kyushu on August 9, 1945, and the release of heretofore unknown amounts of energy resulted in an unprecedented situation. Much of the energy released was in the form of radiation, the remainder and greater part of the energy being released as heat. An attempt has been made to determine the distribution and the effects of the radiation in various zones in the northwestern portion of the city where the bomb was dropped, using the individuals in the various localities as biological test objects.

The information obtained was based on the clinical records and examination of 32 patients in the Urischino Naval Hospital and 17 patients in the Kawatana Municipal Hospital between September 28 and October 31 (Table 1). Forty-six patients in the Omura Naval Hospital were visited once. These three hospitals had had 1,010 victims of the atomic bombing as patients so the 95 individuals still there six weeks after the blasting represented the more badly injured survivors. As these hospitals were the largest ones available to care for the injured they should represent a good cross-section of the more badly injured and are a high percentage of those who managed to survive and yet needed hospitalization.

The disintegration products of plutonium fission produced by the nuclear chain reaction consist of fission fragments, neutrons, and beta particles, and cause a transformation of the remainder of the mass into heat, gamma rays, and radiant energy, the latter including ultraviolet, visible and infra-red radiation. Since these products produce similar reactions in the body it is difficult to say with certainty what part each of these products had in producing the various skin and systemic reactions found in these patients. Fortunately, though, it is found, as would be expected, that there is a marked variation of intensity of these products in various areas of Nagasaki, and it is logical to say that if in a zone one of them predominates, then this product of fission must be producing the prevailing reaction found there. So in order to facili-

TABLE I

	Kawatana Hospital		Urischino Hospital	
	Number	Per Cent	Number	Per Cent
Died	73	26.5	38	18.0
Discharged	170	61.6	145	68.8
Remaining	33	11.9	28	13.2

Table I shows the survival statistics on 487 cases in the Kawatana and the Urischino Hospitals. These figures were given independently by the two hospitals and show sufficiently good agreement to make them of statistical value.

tate the study of these patients they were grouped according to the zone of the city they happened to be in at the time of the explosion. The zones were chosen to show the different effects produced in individuals at various distances from the center of the explosion.

DISTRIBUTION INTO ZONES

Zone 1 which extended from the center of the explosion to a distance of 1,000 meters could be called the lethal zone, as

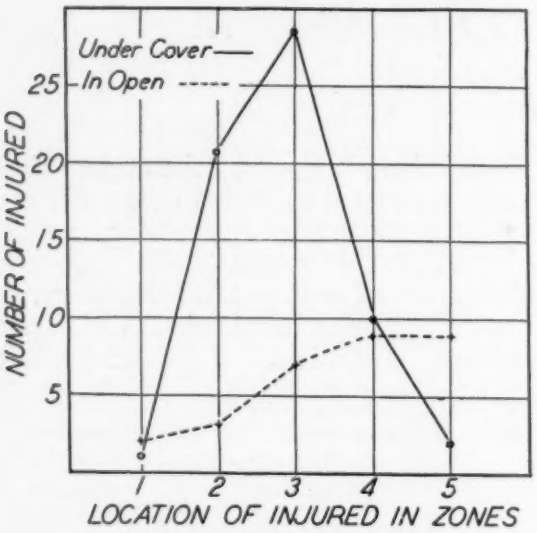


FIG. 1. Distribution of the atomic bomb patients into five zones and their grouping into those in the open at the time of the bombing and those under cover.

there were very few survivors there. Zone 2 which extended from 1,000 to 1,250 meters was the zone where survivors showed maximum irradiation effects. In the third zone, from 1,250 to 1,500 meters were the individuals showing slight irradiation effects. It is the comparison of patients in zones 2 and 3 that gave information on radiation distribution. Zone 4 extended from 1,500 to 1,750 meters and the area beyond 1,750 meters was designated as zone 5. In the last three zones severe superficial burns but practically no irradiation effects were found.

If the groups are to be homogeneous, other factors than the distance from the explosion must be taken into consideration. It would be expected that people who had cover such as a roof and the walls of a building would be more protected than those in the open and should be classified accordingly. It is also necessary to consider the type of roof, for a thick concrete roof or wall will give more protection against the irradiation than will a thin paper one or even tile. It must be considered, too, whether the individual was near a window facing the radiation source and whether the patient was standing or resting on his haunches, as in the latter case the area of the body exposed to irradiation and blast is much less.*

The distribution of the survivors under cover who have mostly radiation reactions is shown by the solid line in Figure 1. There were only 3 survivors in the lethal zone 1 and they were all within 50 meters of zone 2. Since there were so few people in this series in spite of the area being the center of the industrial section of the Mitsubishi Steel and Iron Works it can be assumed that almost everyone was killed outright. But little information could be obtained about this group. The greatest percentage of the people in this study were at the Mitsubishi Ordnance Plant which lies in zones 2 and 3. Considerable numbers of people must have survived in zone 2 for there are 21 in this series of patients requiring hospitalization.

PENETRATING RADIATION EFFECTS

There were 9 people in concrete buildings in zone 2 (where roentgen sickness would be expected), 4 of whom had only mild evidence of roentgen sickness and no sign of burns. They were admitted to the hospital for other injuries. There remained 12 people who were under less adequate protection in zones 1 and 2 who suffered severe roentgen sickness. The roentgen sickness seemed to be quite similar to that usually seen with heavy total body irradiation.

* This point is exemplified by the only man in zone 1 who was out in the open yet survived. He was resting on his haunches and reported that two men who were standing by talking to him at the time of explosion died three days later.

Some individuals with very severe symptoms died. There were profuse vomiting, hematemesis, melena and diarrhea. Petechial hemorrhages were also seen in 3 cases involving the skin (Fig. 2), and 3 the retina. In zone 3 the symptoms were much less severe and in zones 4 and 5 no symptoms other than a loss of appetite for a few days after irradiation were reported. There was a definite tendency for the roentgen sickness to reappear during the middle of September, one month after irradiation. In no case was a typical erythema due to gamma rays reported. There was no epidermolysis reported. The patients who had severe irradiation sickness also lost considerable amounts of weight (Fig. 3). It is difficult to evaluate the weight loss in the group as much of it may have been due to the lack of food and care.

The two possible sources of this penetrating irradiation are gamma rays and neutrons. The neutrons are one of the most important lethal agents throughout zone 1. The number of high speed neutrons beyond zone 1 is much smaller than the number of gamma-ray quanta due to the more rapid absorption of the neutrons. However, the biological effect of neutrons is at least seven times greater than that of gamma rays, so this smaller number of neutrons may be producing a very appreciable biological effect, and neutrons as a source of penetrating radiation in zones 2 and 3 cannot be eliminated.

Fig. 2. Petechial skin hemorrhages in normal skin.

SUPERFICIAL RADIATION EFFECTS

The distribution of survivors with superficial burns and small amounts of penetrating radiation is shown as a broken line in Figure 1, This was by far the most widespread reaction, being found throughout all the zones and as far as 2,500 meters from the radiation source. The people in the open in zones 1 and 2 received both penetrating and superficial radiation and usually died, so the greatest number of survivors were in zones 3, 4, and 5. They reported seeing the flash of the explosion, but it was not until

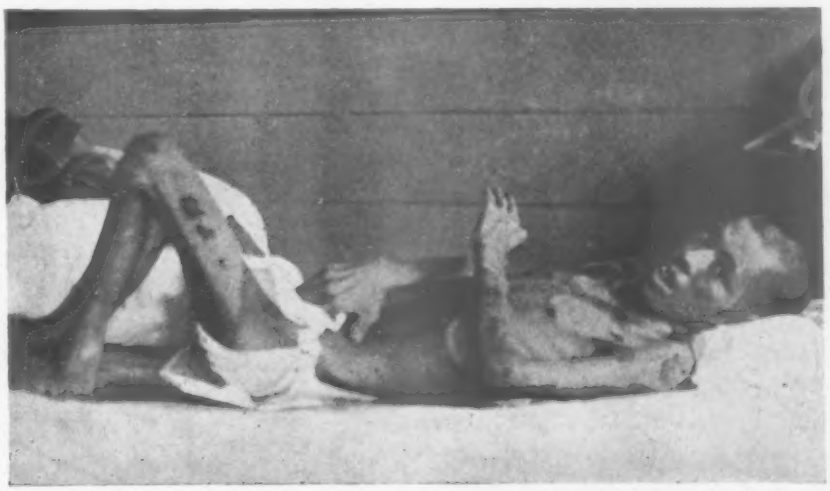


Fig. 3. Emaciated atomic bomb patient who had suffered from roentgen sickness.

FIG. 4. Superficial burns on side of face and neck where skin was not protected by cap. Short-sleeved shirt protected the proximal portion of arm and chest. This patient was on deck of a ship 2,500 meters from the center of the explosion.

several seconds had passed that they realized they had been injured. No heat was felt, and it was only when they looked down that they realized they had been burned. Almost any article of clothing seemed to give them adequate protection. There is quite good evidence that these burns were not due to gamma rays as they appeared immediately and also as several thicknesses of cloth would hardly absorb even the softest gamma rays and the gamma rays produced by nuclear fission are of very high energy (Fig. 4). Additional evidence is found in Figure 5, where it is noted that the effective agent was able to penetrate a single thickness of cloth and produce pigmentation later on, but was not able to penetrate several thicknesses of cloth at the seams of the clothing. The burned areas were always facing the radiation source and their severity fell off rapidly when the radiation struck the body at a tangent. In all cases the healing of the areas was rapid and complete. In October all such areas had healed in the patients seen in this study. The areas themselves when healed were quite typical in that there was a depigmented central area covered by otherwise normal appearing skin. Surrounding this was an irregular pigmentation several centimeters wide, extending into the normal skin. This is quite commonly seen around roentgen therapy fields.

EPILATION

Epilation was almost completely confined to patients in zones 2 and 3; 76 per cent of individuals in zone 2 and 22 per cent in zone 3 lost part of their hair (Fig. 6). The degree of epilation in zone 2 was greater (Fig. 7). In the outer zones there is a smaller percentage of individuals epilated and the degree is also less. Except in 1 and possibly 2 cases the epilation was quite uniform over the whole head, and not just confined to the side exposed to the center of radiation. Many people were able to name a definite day when their hair began to fall out.

AMENORRHEA

The figures on menstruation were calculated from 29 women whose menses had been regular before August 9. Ten out of 11

FIG. 5. Patient showing increased pigmentation where a single thickness of cloth covered her and no reaction where there were several thicknesses of cloth. The protection given by a seam down the center of her back shows clearly.

of these women in zone 2 and 9 out of 12 in zone 3 had amenorrhea after the bombing. In zones 3 and 4 there were 2 cases where the menses were skipped for the first month and scant for the two following months, and 2 cases where there was a scant menstrual period immediately following August 9 and none the two following months. These women were considered as having amenorrhea. However, the finding of 2 cases of amenorrhea in zone 5 suggests the possibility that there was a psychological as well as a physiological factor.

FLYING DEBRIS

Those individuals who were indoors were subjected to injury from flying debris, especially if they were near windows. The concussion showered glass fragments with great velocity so that they penetrated deep into the muscles (Fig. 8). Usually the fragments were rather small and very numerous and produced great trauma. When these patients were seen six weeks later the glass fragments were still in the muscle but the lacerations had completely healed (Fig. 9).

FIG. 6. Partial epilation. Scars are due to flying debris, mostly glass.

FIG. 7. Severe epilation. The wound on the side of the head resulted from falling debris. The skull is exposed in the center of the wound.

BLOOD STUDIES

In a series of 20 cases in zones 2 and 3 the lowest red blood count was 2.3 million. The hemoglobin determinations were so varied they were not considered reliable. When sedimentation rates were done there was a marked immediate increase in the rate with a gradual return to normal.

The white blood count studies are based on 32 cases at the Urischino Naval Hospital.* As would be expected, there was a marked fall in the white blood count (Fig. 10). To determine just how long it required for the maximum fall in the white blood count to take place in individuals with severe irradiation reactions 12 cases were selected. They all were in zones 2 and 3, all had severe roentgen sickness, and all had marked epilation. The plot of their white counts as a function of time is shown in Figure 11. Twenty-one days after irradiation some patients with severe irradiation reactions still showed normal or only

* These data were supplied by Commander Nunemitsu Kiso.

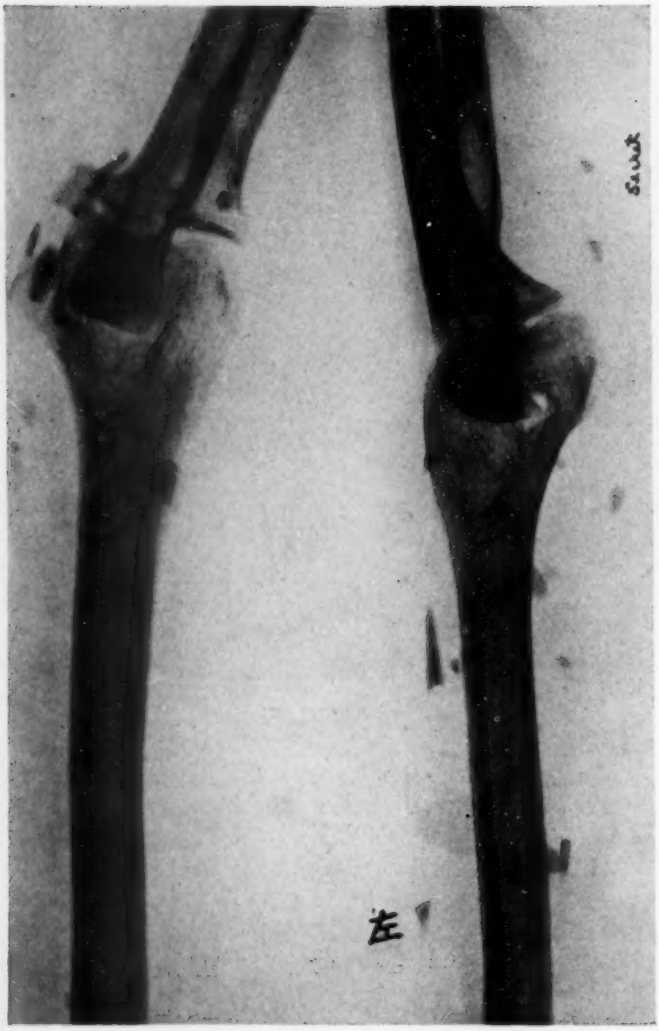


Fig. 8. Roentgenogram showing glass fragments in the muscles.

slightly depressed counts. After this time the count dropped off and reached a maximum depression near the twenty-eighth day. The differential counts were inadequate but in many smears not a single lymphocyte could be seen.

In zone 2 the average count of 11 cases dropped to a low of 980 (Fig. 10); the lowest was 514. There was one normal count in a patient who was protected by a concrete roof. In zone 3 the average was 3,750, with a low of 1,000 and several normal counts. There were 16 cases in this group. The average white blood cell count of patients beyond zone 3 was 4,780 and is taken to be

Fig. 9. Patient injured by flying glass whose lacerations have healed though the fragments are still in his body.

a normal value as they have received very small amounts of radiation.

To calculate the relative intensity of irradiation it can be assumed at this time that the irradiation in the center of zone 3 is unity. It is desired to calculate the relative intensity of irradiation in zone 2. Since

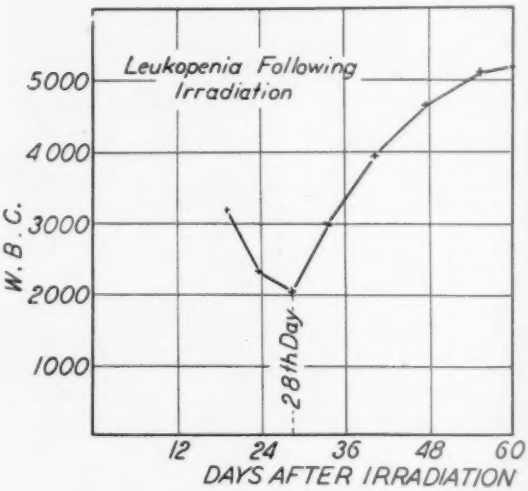


Fig. 10. Average fall in white blood cell counts of 12 cases with severe irradiation reactions plotted as a function of time. The much desired earlier counts were not available.

all such biological relations are a matter of probability (i.e., a unit of energy striking a certain sensitive area in the cell), the relationship

$$N_x = N_o e^{-h^2 I_x^2} \qquad (1)$$

gives the typical probability "S"-shaped curve.

N_x = the white blood cell count at a distance "x" from the center
N_o = the normal white count
x = 1,375 meters, the center of zone 3
I_x = the intensity of irradiation at distance "x" from the center
h = a term to give the slope of the curve, and with its proper value will make the intensity of radiation equal to one, as is required.

To calculate the value for this "h", substitute in equation (1),

$$3750 = 4780\, e^{-h^2 I^2}$$

and solve for "h^2", which is found equal to 0.24. Knowing "h^2", one can calculate the relative intensity of irradiation, "I_x", for any value of "x". To find the irradiation at 1,125 meters, substitute in equation (1) the white blood cell count found in Figure 10 at 1,125 meters and use the average normal white blood count in the outer zone, which is 4,780.

$$980 = 4780\, e^{-.24 I_x^2}.$$

Solving for "I_x" it is found to be equal to 2.54, which is the desired relation of irradiation intensities in the central parts of zones 2 and 3.

CALCULATION OF NUMBER OF ROENTGENS

Taking this relationship, 1:2.54, it is possible to calculate by substitution in equation (2) the coefficient of absorption, "u," for the gamma rays in air; and from this value the penetrability and energy of the gamma rays produced by the atomic bomb are estimated.

$$I_x = I_o \frac{e^{-x/u}}{r^2} \qquad (2)$$

I_x = the intensity of radiation at a distance "x" from center
I_o = the intensity of radiation at 1 meter

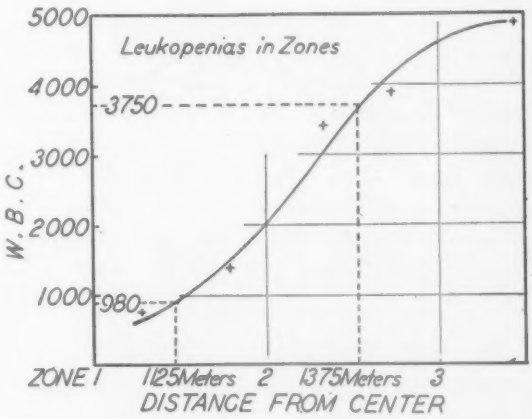


FIG. 11. Average degree of leukopenia developed in the various zones.

$e^{-x/u}$ = the absorption by air
r = the distance from the center
u = the coefficient of absorption of the penetrating radiation in the air.

Since the ratio of the two intensities, 1 to 2.54, is known, and since I_o is cancelled, the coefficient "u" is calculated by substituting the distances 1,125 and 1,375 in equations (4) and (5). Equate them in equation (6), and solve for "u".

$$I_{1125} = 2.54 I_{1375} \qquad (3)$$

$$I_{1125} = I_o \frac{e^{-1125/u}}{(1125)^2} \qquad (4)$$

$$I_{1375} = I_o \frac{e^{-1375/u}}{(1375)^2} \qquad (5)$$

$$\frac{e^{-1125/u}}{(1125)^2} = 2.54 \frac{e^{-1375/u}}{(1375)^2} \qquad (6)$$

"u" is found to be 480 meters and is the distance at which the radiation will fall off to "e^{-1}" of its original value.*

Taking the value 480, which gives the amount of radiation absorbed, the final calculation of the number of roentgens can be found. The number of gamma quanta or neutrons released, or the number of disintegrations produced, by the bomb is about 6×10^{24}. This number will drop to a value of

$$6 \times 10^{24} \times \frac{e^{-1250/480}}{4(1.25)^2 \times 10^{10}} = 2.37 \times 10^{12}$$

disintegrations per square centimeter at a

* $e^{-1} = 1/0.368$.

distance of 1,250 meters. The denominator is a term taking the geometry into consideration and the numerator the amount of radiation absorbed by air. To convert this to roentgens, the number of disintegrations must be divided by 5×10^9, which gives 473 r/sq. cm. The value 5×10^9 is the number of disintegrations of gamma rays that produce 1 roentgen.

SURVIVAL TIME

Figure 12 shows the survival time of 38 patients who died in the Urischino Hospital.

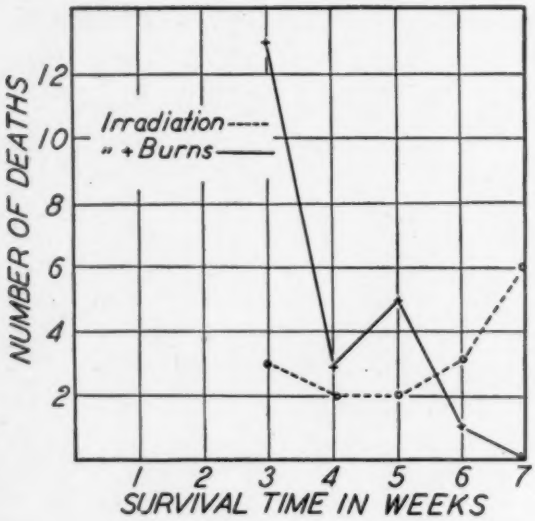


FIG. 12. Comparison of survival times of patients with pure irradiation reactions and those with irradiation and also superficial burns.

The solid line shows the group with pure irradiation reactions and the broken line indicates those with irradiation and also superficial burns. It can be concluded that those patients who had the combined injury died much earlier than those with pure irradiation. In the latter group the greatest number died at the end of the seventh week, which demonstrates the delayed reaction of pure irradiation injuries.

CONCLUSION

From this study one can conclude that in this group of 92 individuals found in zones 2, 3, 4, and 5, adequate protection is provided against the radiation and burns in 4 cases in zone 2 by a concrete roof. The only injury sustained in these cases was from flying glass and concussion. In this region wooden buildings gave sufficient protection to prevent superficial burns but gave no protection against the penetrating radiation. Even clothing will give protection against the agent producing the burns. Many people sustained severe injury from the radiation and burns but apparently are not permanently injured. The delay in the fall of their white blood counts until the twenty-eighth day would indicate it is not a reliable immediate indication of irradiation, as serious radiation injury may be received before the white count would indicate the danger. From the fact that no heat was felt by the persons receiving severe burns and from the general appearance and rapidity of healing, one must conclude that radiation (i.e., ultraviolet, visible light and infra-red) given off by the bomb was the heat-producing agent.

The coefficient of absorption for the penetrating radiation produced by the atomic bomb is $e^{-1} = 480$ meters. The value of 473 r for the calculated radiation intensity at 1,250 meters is a probable value and is of the correct order of magnitude. The return of the white blood cell counts to normal in patients who have received large amounts of radiation does not indicate the patient will necessarily recover.

New Britain General Hospital
New Britain, Conn.

The author wishes to point out that these calculations and deductions are based on a rather small, select group of individuals, chosen to show the distribution of radiation. No attempt has been made to study the mortality statistics of the population as a whole. All numerical values used in the calculations are common knowledge, as the author does not have access to confidential documents.

SUPERVOLTAGE RADIATION

A REVIEW OF THE CASES TREATED DURING AN EIGHT YEAR PERIOD (1937–1944 INCLUSIVE)*

By GEORGE W. HOLMES *and* MILFORD D. SCHULZ
BOSTON, MASSACHUSETTS

THE object of this review is to report the results of eight years' work with roentgen rays generated at 1,200 kv.,† to point out some of the advantages and disadvantages of this form of radiation, and from the data available, to state as far as possible the type of patient likely to be benefited by it.

The generator used was of the Van de Graaff constant potential type. It has been fully described by Van de Graaff, Trump Cloud, and Dresser. Some changes were made in the structure of the apparatus during the period covered by this report, but the character of the radiation was not appreciably changed.‡ The output of this generator at 1,200 kv. and 0.5 ma. of current, when filtered through 2 mm. of lead, 5 mm. of copper and 2 mm. of aluminum, is 45 roentgens per minute, measured in air, at 70 cm. distance using the Victoreen roentgen meter. Its half-value equivalent is 9.8 mm. Cu and its minimum wave length is 0.012 Å. The depth dose at 10 cm. below the surface, using a 100 sq. cm. field and a 70 cm. distance, as measured in a Masonite presdwood phantom with a total depth of 20 cm., is about 52 per cent of the surface dose. The surface backscattering is 6.7 per cent, and the exit dose is 7 per cent. The point of greatest intensity is about 2 mm. below the skin surface. This fact is of considerable importance as it explains the minimal skin reaction seen when even large doses are given. A dose of 3,000 r at 10 cm. depth can be given using two opposing portals at a daily dose of 300 r without producing more than a mild erythema over the areas treated. "Cross firing" through more than two fields is usually unnecessary as the maximum dose which the internal organs will tolerate can be given without serious skin damage.

With the physical factors just enumerated in mind, it would seem that the type of patients most likely to be benefited by this form of treatment are those suffering from deep-seated malignant tumors, particularly those in whom the tumors are so situated that no vital organs are exposed to the rays. In order to determine the effectiveness of supervoltage radiation we have treated a small number of cases in which there was a possible chance of cure by other methods. We have also treated, when it seemed desirable to avoid skin damage, a small number in which good results have been obtained in the past with lower voltage—for example, a single lymphomatous mass in the abdomen or chest. For several years it has been the policy of this clinic, based on end-results, to advise surgical rather than radiation treatment, unless surgical removal of the tumor was impossible or the operative risk considerable. Exceptions to this general statement may be taken when complete surgical removal would result in irreparable functional loss, or when the tumor is known to be of a high degree of malignancy.

This method of selection should be considered when evaluating the results shown in this report. Nearly all of the cases were incurable by standard procedures at the time supervoltage radiation treatment was undertaken. Beneficial effects, if any, from it would therefore appear in the end-result tables as increased life expectancy and not

* From the Department of Radiology, Massachusetts General Hospital, Boston, Massachusetts. Read before the New England Roentgen Ray Society January 18, 1946.

† This analysis includes patients treated at the Collis P. Huntington Memorial Hospital from 1937 through 1941 and at the Massachusetts General Hospital from 1940 through 1944.

‡ The radiation in use at the Huntington Memorial Hospital was delivered at 1,000 kv. and 2 ma. of current.

as five year cures. In studying the data and in preparation of the tables and graphs here presented, this fact has been kept in mind. It seemed desirable also, as far as possible, to so arrange the data that comparison could be made with results obtained with the older forms of treatment, especially with 200 kv. radiation. For this reason the grouping has been arranged to conform with published tables of life expectancy, particularly those of Nathanson and Welch. It was also to be expected that supervoltage radiation would be more effective in some groups than in others, and this supposition was also considered in arranging the data.

METHOD OF STATISTICAL CALCULATION

During the period covered, a total of 1,835 cases were treated with supervoltage radiation. In each of the groups into which these cases were subdivided for study, certain common factors appeared. An explanation of these common factors here will obviate the necessity of repeated explanation. One hundred and thirty-five of the patients treated (7.3 per cent) were referred by their local physician, in many instances from distant localities. These private patients returned to their attending doctors shortly after treatment and, since no follow-up was attempted, they were discarded from the statistical analysis. Ninety-nine patients (5.3 per cent), lost track of at varying times after treatment, were counted as dead as of the date of last observation, although it is quite possible that some of them are still living. The average delay between onset of disease and institution of supervoltage irradiation was determined and in the presentation of each group will be termed "average delay."

In arriving at survival rates, the date of the first treatment with supervoltage was taken as a base line for post-treatment survivals. The tables showing survival rates according to the year treatment was given are based on the actual number of cases that had an opportunity to live the given period of time. When available, the life-expectancy curves of Nathanson and Welch were used as a basis for comparison of results. Their work covered a considerable number of cases treated by methods other than supervoltage irradiation over a period of years ending just prior to that at which the present study began. Their life-expectancy curves show a calculated survival rate after the onset of disease, the calculation being based on the supposition that those patients, who were known to be alive but presumably would die, would do so at the same rate as the known dead The graphs in the present report were calculated in the same manner and in most of the groups the results are probably comparable.

Certain seeming discrepancies in the calculated survival after onset as compared with the actual survival are due to two facts: (1) in small groups such as those in our series, the percentages may be distorted by a few individuals in certain years who have survived more than the usual time, and (2) in the life-expectancy graphs the calculation is based on the entire group while the survival tables are based on the number of cases that had opportunity to live a given length of time. There is, also, a rather long average, and an extremely long individual delay in the institution of supervoltage irradiation after onset of symptoms. Many of the cases came to supervoltage therapy late in the course of their disease after other forms of treatment had failed. Accurate data regarding the stage of the disease in the various groups are not available.

MATERIAL STUDIED

Oral Cavity

(Excluding tongue and everything behind anterior pillars)

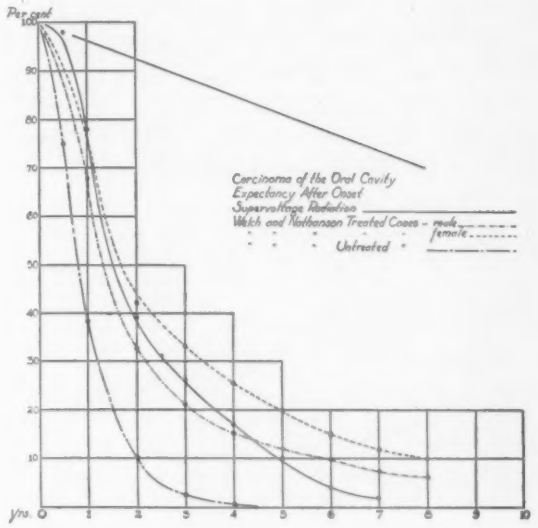
76 cases treated	76 cases analyzed
65 males: 11 females	6 cases (7.9%) lost
Average age 63 years	57 dead: 13 living
0 cases discarded	Average delay 11 months

Four different lesions in the mouth are arbitrarily studied together because the individual groups were too small to permit

of separate analysis. It is realized, however, that lesions within the mouth respond differently according to the location. In 16 of the cases the lesion was on the buccal surface; in 12, on the floor of the mouth; in 5, on the hard palate; in 11, on the soft palate, and in 32, on the alveolar ridge. Of the entire group, 31 per cent were not primary cases, having had previous surgery or treatment with other types of radiation.

A calculated 50 per cent of the entire group were dead seventeen months after onset of disease (Graph 1). Of those who had an opportunity to live five years after treatment, 7 per cent are known to have done so (Table 1), and a calculated 10 per cent of the entire group have lived five years after onset of disease.

No similar group treated with lower voltage roentgen rays is available for comparison. The patients in this group were with few exceptions considered incurable. Taylor and Nathanson, in their discussion of carcinoma of the oral cavity, report local cure in from 20 to 48 per cent of all cases, depending upon the location of the tumor, but their data cannot be compared with the material reported here as it includes many more favorable cases as well as cases treated surgically. All that can actually be determined from this study is that supervoltage irradiation has not increased the life expectancy in the type of case under consideration.



Graph 1.

Tongue

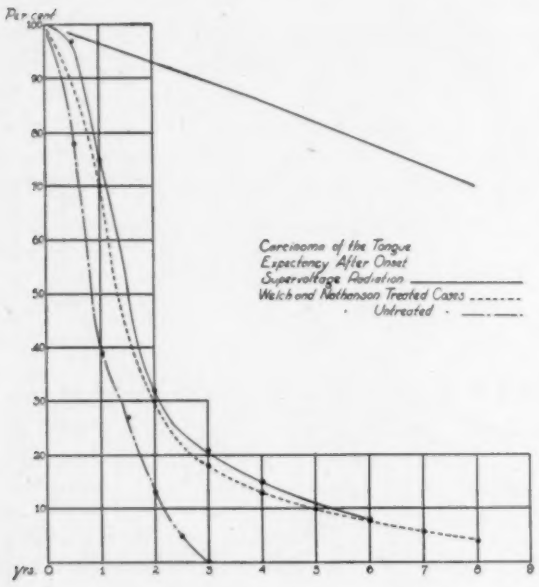
60 cases treated	60 cases analyzed
54 males: 6 females	2 cases (3%) lost
Average age 65 years	48 dead: 10 living
0 cases discarded	Average delay 12 months

Table I

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF ORAL CAVITY: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	8	7	15	10	12	12	4	8	76	
Survivals at end of										
6 months	6	5	9	9	8	9	3	2		68
12 months	3	5	7	5	6	4	1	1		46
18 months	2	4	6	4	3	3				35
24 months	1	4	5	2	2	3				27
36 months	1	4	5	2	1					25
48 months	0	3	2	1						15
60 months	0	1	1	1						7
72 months	0	1	0							7
84 months	0	1								1

A calculated 50 per cent of the entire group were dead nineteen months after onset of disease (Graph 2). Of those who had an opportunity to live five years after treatment, 9 per cent are known to have done so (Table II), and a calculated 11 per cent of the entire group have lived five years after onset of disease.



Graph 2.

About one-half of the cases had received either surgical or high voltage roentgen treatment before receiving supervoltage irradiation, some had received both. The survival rate in this group was no lower than that of the group as a whole. The normal death rate for persons in this age group is high, and a considerable number of patients who seemed to be doing well, as far as control of tumor growth was concerned, did not survive five years. For example, one man of eighty-three died six months after satisfactorily completing treatment.

The dosage used varied considerably. In the early years, two fields were used. Later, treatment was given through one field only. The total dose, measured in air, varied between 4,000 and 7,000 r. Even with doses up to 6,000 r, given through a single field, skin damage was not alarming and complete healing occurred.

A comparison of the results obtained with supervoltage radiation with those obtained when lower voltages are used is shown in Graph 2. A somewhat similar group, reported by Nathanson and Welch,

Table II

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF TONGUE: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	8	16	4	5	9	7	5	6	60	
Survivals at end of										
6 months	4	12	4	4	6	6	4	4		75
12 months	2	9	3	4	3	2	2			47
18 months	2	2	1	2	2	1	1			20
24 months	0	1	1	2	2	1				15
30 months	0	1	1	2	1	1				13
36 months	0	1	1	2	1					12
48 months	0	1	1	2						12
60 months	0	1	1	1						9
72 months	0	1	1							7

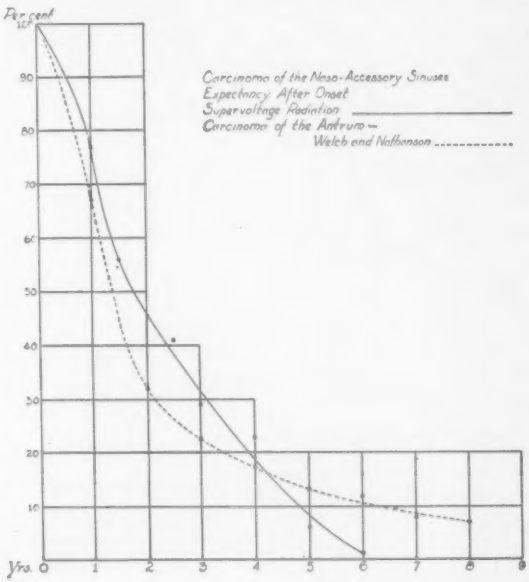
treated with surgery, high voltage roentgen rays, and/or radium show a five year survival rate of 15 per cent.

Nasopharynx and Nasal Accessory Sinuses

55 cases treated	53 cases analyzed
34 males: 21 females	2 cases (3.8%) lost
Average age 57 years	34 dead: 17 living
2 cases discarded	Average delay 7.6 months

A calculated 50 per cent of the entire group were dead 21.5 months after onset of disease (Graph 3). Of those who had an opportunity to live five years after treatment, 13 per cent are known to have done so (Table III), and a calculated 6 per cent of the entire group have lived five years after onset of disease. The best case in this group is a man who has carcinoma of the antrum and who has lived seventy-two months since treatment but now has metastatic disease in the cervical lymph nodes without local recurrence.

A large percentage of the cases in this group had some form of radiation before supervoltage therapy was undertaken. This is especially true of the cases treated in the early years. At present, inoperable cases are treated with supervoltage irradiation only. The optimum dose is 7,000 r, measured in air, given through a single field. Because of previous treatment, or for other reasons, only a comparatively small number received this dosage. The exposure in antral cases was anterior over the orbital and malar regions. The beam was directed



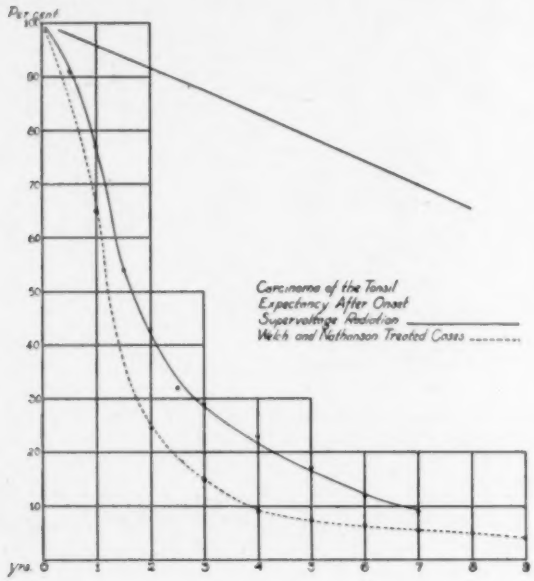
Graph 3.

Table III

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF NASOPHARYNX: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	5	4	6	7	8	7	9	7	53	
Survivals at end of										
6 months	5	2	4	4	6	6	8	5		75
12 months	4	1	3	4	6	3	5			56
18 months	3	1	2	4	4	3	4			46
24 months	3	1	2	3	4	3				43
30 months	3	1	1	3	4	3				40
36 months	3	1	1	1	3	0				27
48 months	1	1	1	0	1					18
60 months	1	1	0							13
72 months	0	1								11

obliquely backward toward the opposite side. No attempt was made to protect the eye. The reactions have been quite sharp; conjunctivitis has been troublesome, and not all cases recovered without damage to the globe. In comparing supervoltage with other forms of radiation it is necessary to give considerable weight to clinical impressions and individual case histories, as the statistical data available are of little help. Further study is necessary before any definite conclusions can be reached, but it is our opinion that supervoltage irradiation is worth while, and should be given further trial.



Graph 4.

Tonsil

38 cases treated	36 cases analyzed
29 males: 9 females	3 cases (8%) lost
Average age 65 years	18 dead: 15 living
2 cases discarded	Average delay 6.5 months

A calculated 50 per cent of the entire group were dead twenty months after onset of disease (Graph 4). Of those who had an opportunity to live five years after treatment, 21 per cent have done so (Table IV), and a calculated 17 per cent of the entire group have lived five years after onset of disease.

It is well known that tumors in this area are of a high malignancy, that they are ordinarily radiosensitive, and that they metastasize early. The group here reported is no exception. As with other forms of radiation, destruction of the primary tumor was the rule; control of metastases was slightly better than by the older methods. The dose varied somewhat, usually because

Table IV

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF TONSIL: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	4	0	2	8	9	3	1	9	36	
Survivals at end of										
6 months	4	0	2	5	6	3	1	6		75
12 months	3	0	1	5	3	3	1			60
18 months	3	0	1	3	3	1	1			45
24 months	3	0	1	2	3	1				39
30 months	3	0	0	2	2	1				31
36 months	3	0	0	2	2					30
48 months	3	0	0	2	1					26
60 months	2	0	0	1						21
72 months	2	0	0	1						21

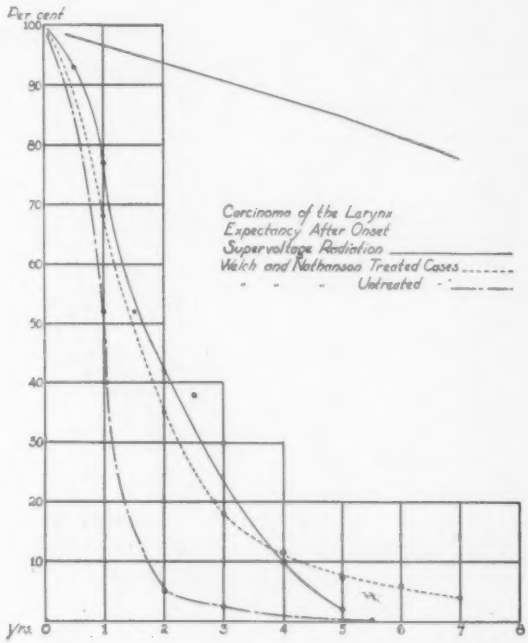
of previous treatment. The optimum dose was 6,000 r, measured in air, given through a single field on the side of the lesion. Skin reactions were confined to the treated side of the neck and were less troublesome than in cases treated with 200 kv. radiation. Because of the proximity of the lesion to one external surface, the single lateral field offers some advantage in that with its use the patients are more comfortable. The survival rate with supervoltage treatment has been somewhat better than with 200 kv. radiation, and we believe it should be given further trial.

Larynx

50 cases treated	49 cases analyzed
41 males: 9 females	9 cases (18%) lost
Average age 65 years	36 dead: 4 living
1 case discarded	Average delay 10 months

A calculated 50 per cent of the entire group were dead twenty months after onset of disease (Graph 5). Of those who had an opportunity to live five years after treatment, 3 per cent are known to have done so (Table v), and a calculated 2 per cent of the entire group have lived five years after onset of disease.

It should be emphasized that the cases in this group were particularly unfavorable ones. Because the results of irradiation of carcinoma of the larynx with 200 kv. were known to be so satisfactory, only cases considered beyond cure were given super-



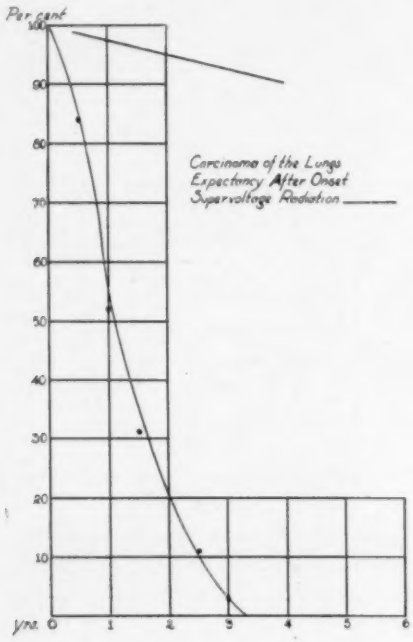
Graph 5.

Table V

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF LARYNX: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	4	8	8	10	9	8	0	2	49	
Survivals at end of										
6 months	3	7	6	9	4	4	0	1		70
12 months	2	4	2	2	3	3	0			34
18 months	2	3	2	2	2	2				28
24 months	1	3	2	1	2	1				21
30 months	1	3	2	1	2	0				19
36 months	1	0	1	1	1					10
48 months	0	0	0	1	1					5
60 months	0	0	0	1						3
72 months	0	0	0							0

voltage radiation. Schatzki studied 33 consecutive cases treated in this clinic with 200 kv. radiation. He found 11, or 33⅓ per cent, alive and apparently free from disease three years after the beginning of treatment. Nine of his 33 cases had glandular metastases at the time of treatment; only 1 of the 9 lived five years. Since all the cases treated with supervoltage irradiation were in an advanced stage of the disease, the results of treatment in the two groups are comparable and were approximately the same. There is no evidence that the higher voltage, at the dosage used, was more effective in the treatment of glandular metastases than the lower voltage. Both methods were fairly effective in controlling the primary tumor. From the limited data available, there seems to be no special indication for the use of supervoltage radiation in this group, although here again the advisability of using a single lateral field may be considered. It is possible that better results would be obtained with a larger total dose and longer time factor. The planned dose in this group was 6,000 r, measured in air, given through a single field in daily doses of 300 r.



Graph 6.

Lungs

152 cases treated	143 cases analyzed
139 males: 13 females	2 cases (1.4%) lost
Average age 54 years	106 dead: 35 living
9 cases discarded	Average delay 7 months

A calculated 50 per cent of the entire group were dead 12.5 months after onset of

Table VI

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF LUNG: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	0	1	3	14	32	19	31	43	143	
Survivals at end of										
6 months	0	0	3	8	14	11	11	27		52
12 months	0	0	2	3	6	8	5			24
18 months	0	0	0	3	4	4	1			12
24 months	0	0	0	1	3	3				10
30 months	0	0	0	0	3	1				6
36 months	0	0	0	0	0					0

disease (Graph 6). No case has as yet lived three years after treatment. Only 4 cases were treated with supervoltage irradiation before 1940. All are dead. There is, therefore, no patient in the entire group who has had an opportunity to live five years. Of those who have had an opportunity to survive thirty months after treatment, only 6 per cent have done so (Table VI), and a calculated 11 per cent of the entire group have lived thirty months after onset of disease.

Histopathologically, 31 per cent of the carcinomas were epidermoid, 5 per cent adenocarcinoma, 6 per cent oat cell, 11 per cent undifferentiated, 20 per cent unclassified, and 27 per cent of the group had no biopsy. The oat cell carcinomas have had the best percentile survival; 33 per cent were living one year after treatment and 11 per cent thirty months after treatment. Better results in this group were to be expected as the tumor is quite radiosensitive, and, because of the known poor surgical results, more favorable cases were referred for irradiation. It has been possible, as a rule, to cause a complete disappearance of the primary tumor, but since distant metastases usually occur early, the patient eventually succumbs. In all of this group, metastases had already occurred at the time of treatment.

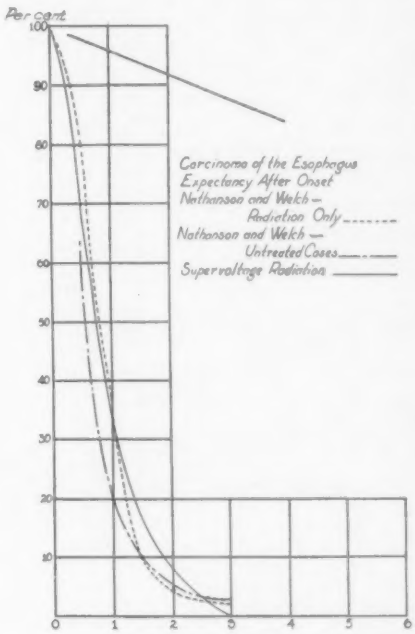
Thoracic surgery has made great progress during the past five years. Since it no longer carries a high operative mortality, and since irradiation has failed to produce any cure, it seems wise to refer for surgical treatment all cases in which there is a chance of cure. Supervoltage radiation has been worth while for palliation, and in a fair percentage of cases has prolonged life. With it, adequate dosage can be given through small fields, thus avoiding exposures of large areas of infected lung. We believe that this form of treatment is of value in carcinoma of the lung.

Gastrointestinal Tract
Esophagus

98 cases treated	95 cases analyzed
73 males: 25 females	0 cases lost
Average age 63 years	88 dead: 7 living
3 cases discarded	Average delay 7 months

A calculated 50 per cent of the entire group were dead nine months after onset of disease (Graph 7). No patient lived more than twenty-four months after treatment (Table VII).

Patients with lesions of the upper esophagus did a little better than those with lesions elsewhere in the esophagus.



GRAPH 7.

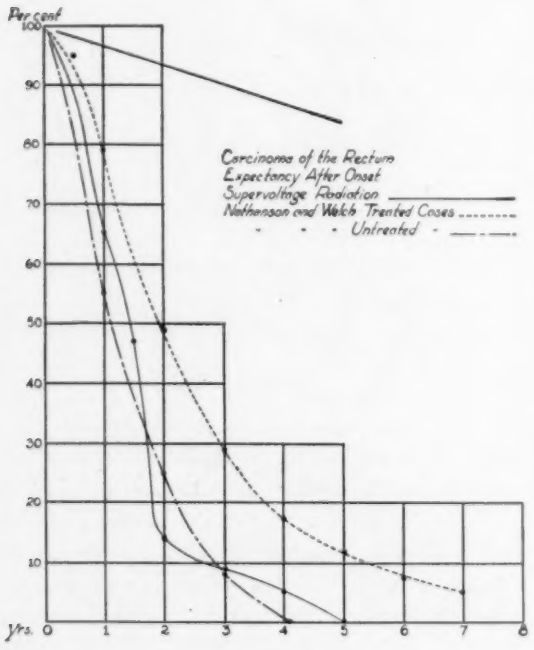
Generally speaking, the lower the lesion, the poorer was the expectancy, confirming previous reports. The majority of patients, particularly those with the tumor in the upper third, showed some improvement after treatment, in that they could swallow better. In a few instances, the primary tumor disappeared completely. All the cases were considered inoperable at the time treatment was undertaken, but undoubtedly some of those treated in the early years would today be considered operable.

Gastrostomy was performed in a few cases only. The usual surgical procedure was biopsy through the esophagoscope or through the open chest. Today, the excellent immediate results of surgical removal,

TABLE VII

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF ESOPHAGUS: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	4	5	3	15	14	25	10	19	95	
Survivals at end of										
6 months	2	3	1	4	2	7	4	4		28
12 months	1	1	0	0	1	2	1			8
18 months	0	1	0	0	1	1	0			3
24 months	0	0	0	0	1	0				2
30 months	0	0	0	0	0					0



GRAPH 8.

especially when the tumor is in the lower third of the esophagus, seem to justify its use, irradiation being reserved for the more advanced cases, or those involving the upper esophagus. Supervoltage irradiation offers some technical advantages, especially if complete destruction of the tumor is to be attempted. The planned dose at the site of the tumor was 3,000 r, but in many instances this dose was not given because of rapid deterioration in the patient's condition. Perhaps in selected cases the dose should have been larger.

There is no evidence from the present data that supervoltage radiation has increased the survival time over the older methods. The immediate cause of death in patients with carcinoma of the esophagus is usually inanition, or respiratory infection, and not extension of the tumor. Destruction of the tumor by irradiation does not seem to change materially the course of events, and this fact may explain the failure of supervoltage irradiation to improve results.

Stomach

9 cases treated	6 cases studied
6 males: 3 females	0 cases lost
Average age 54 years	6 dead
3 cases discarded	Average delay 4.5 months

The average survival after treatment was 5.5 months; the longest survival period being fifteen months. No permanent benefit was effected by supervoltage irradiation, although several patients admitted some relief of discomfort.

Large Intestine, Rectum, and Anus

33 cases treated (7 upper colon, 25 rectum, 1 anus)
14 males: 19 females — 21 cases (*rectum*) analyzed
Average age 55 years — 20 dead: 1 lost
4 cases discarded — Average delay 10 months

Of the 21 cases with lesions of the rectum studied, 48 per cent were known to be dead six months after treatment. One was alive eighteen months after treatment; none lived two years (Graph 8, Table VIII).

Genitourinary Tract
Kidney

15 cases treated — 15 cases studied
13 males: 2 females — 0 cases lost
Average age 56.6 years — 10 dead: 5 living
0 cases discarded — Average delay 14 months

A calculated 50 per cent of the entire group were dead twenty-four months after onset of disease. Of those who had an opportunity to live twenty-four months after treatment, 5, or 41 per cent, have done so. Four patients lived three years and 2 four years. There were no five year survivals.

TABLE VIII

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF RECTUM: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	3	3	1	4	1	5	3	1	21	
Survivals at end of										
6 months	1	3	1	1	1	2	1	0		48
12 months	1	1	0	1	1	0	1			25
18 months	0	0	0	1	0	0	0			5
24 months	0	0	0	0						0

In about two-thirds of the cases there was a definitely favorable clinical response to irradiation. Relief of pain and/or cessation of bleeding, often followed by general improvement in the patient's condition, were apparent. Phillips reports similar, and even encouraging, results in the treatment of carcinoma of the rectum with supervoltage radiation at St. Bartholemew's Hospital in London. Many of our cases, because of previous treatment or because of the patient's condition, did not receive over 3,000 r at the site of the tumor. It is our belief that a better selection of cases with an increase of the tumor dose up to 5,000 r would result in some five year cures, and in some cases might obviate the necessity for colostomy. Supervoltage radiation in cancer of the rectum should, in our opinion, receive further attention.

In about one-half the cases supervoltage irradiation followed nephrectomy; in the remainder, the tumor was inoperable and only a specimen for diagnosis was removed. The small number of patients who survived three years may have received some benefit from the treatment, but it is equally probable that their survival was due to other factors. In general, kidney tumors, with the exception of Wilms' tumor, do not respond to irradiation. From the available, incomplete data, it is not apparent that supervoltage radiation offers any improvement over the older methods of radiation therapy.

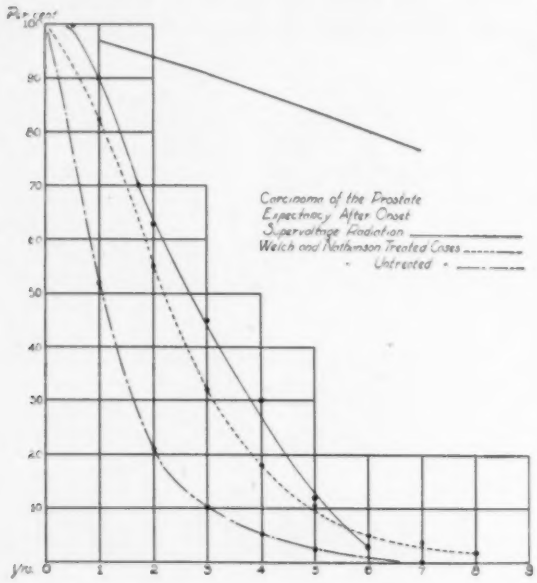
Urethra

6 cases treated	5 cases dead
2 males: 4 females	1 case living
Average age 67 years	Average delay 9 months

One woman, aged fifty-nine, is alive without disease sixty months after treatment. Of the 5 dead, the average duration after treatment was five months, or eighteen months after onset of disease.

Prostate

52 cases treated	35 cases analyzed
17 cases discarded	2 cases (6%) lost
Average age 67 years	27 dead; 6 alive
Average delay 9 months	



Graph 9.

A calculated 50 per cent of the entire group were dead twenty-seven months after onset of disease (Graph 9). Of those who had an opportunity to live five years after treatment, 4 per cent are known to have done so (Table IX), and a calculated 12 per cent of the entire group lived five years after onset of disease.

The five year survival rate of 4 per cent is misleading as only 1 patient was living at the end of that time, and, furthermore, nearly all the patients in this group had had previous surgical or radiation treatment. It is very unlikely that carcinoma of the prostate can be cured by any form of radiation, and this form of treatment, therefore, should be used for the relief of symptoms only. Palliation can probably be obtained with 200 kv. radiation as well as with supervoltage therapy. Massive doses over large areas should be avoided.

Table IX

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF PROSTATE: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	3	7	3	14	6	1	0	1	35	
Survivals at end of										
6 months	3	5	3	13	5	1	0			86
12 months	1	4	1	10	5	1	0			65
18 months	1	4	1	6	5	1	0			53
24 months	0	2	1	4	4	1				35
30 months	0	2	1	4	4	1				35
36 months	0	1	1	4	3	1				28
48 months	0	1	1	1	1					12
60 months	0	0	0	1						4
72 months	0	0	0	1						4

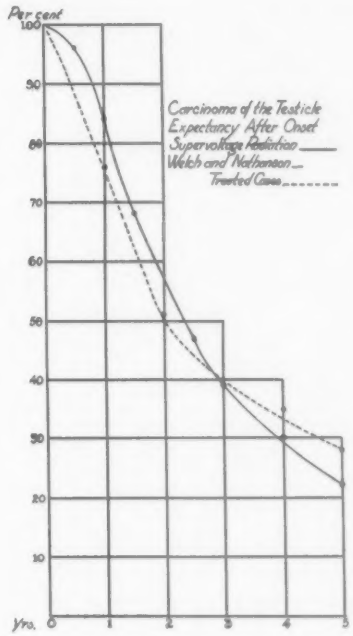
Testicle

40 cases treated — 36 cases analyzed
Average age 38 years — 5 cases (14%) lost
4 cases discarded — 16 dead: 15 living
Average delay 8.6 months

A calculated 50 per cent of the entire group were dead twenty-four months after onset of disease (Graph 10). Of those who had an opportunity to live five years, 29 per cent are known to have done so (Table x), and a calculated 11 per cent of the entire group have lived five years since onset of disease.

The estimated tumor dose used in this group was 2,000 r, the daily dose being 150 r. Treatment was given through four fields, two anterior and two posterior. In some cases, two large fields were used. In a few cases, treatment was given to the opposite side and to the mediastinum. The results are the same as those obtained with 200 kv. using a similar technique. The cases treated with supervoltage radiation, however, showed no permanent skin damage and suffered less roentgen sickness. Since a fair percentage of these young men may be expected to survive, this avoidance of permanent skin damage is important.

The type of tumor in all the patients who have lived more than three years was an embryoma. This fact suggests the possibility that more extensive surgical procedures should have been undertaken when the histopathology of the primary lesion



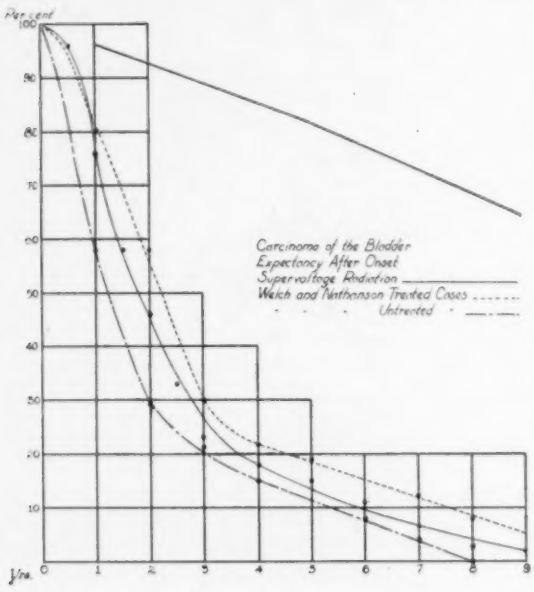
Graph 10.

Table X

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF TESTICLE: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	4	3	2	6	5	5	5	6	36	
Survivals at end of										
6 months	4	2	2	5	3	4	5	5		83
12 months	3	1	1	4	3	4	3			63
18 months	3	0	1	4	3	4				60
24 months	3	0	1	4	3	3				56
30 months	3	0	1	4	3					55
36 months	3	0	1	4	1					45
48 months	2	0	1	2						33
60 months	1	0	1							29
72 months	1	0								25

showed that it was radioresistant, or the tumor dose should have been increased even at the risk of injuring deep-seated organs. The adult type of teratoma is slowly growing and radioresistant, and probably should be treated surgically. The choroid epithelioma is a very rapidly growing tumor which does not respond to irradiation, and treatment should be directed toward the relief of symptoms only.



GRAPH 11.

Bladder

196 cases treated	184 cases analyzed
139 males: 57 females	8 cases (4%) lost
Average age 63 years	131 dead: 45 living
12 cases discarded	Average delay 18 months

A calculated 50 per cent of the entire group were dead twenty-two months after onset of disease (Graph 11). Of those who had an opportunity to live five years after treatment, 8 per cent are known to have done so (Table XI), and a calculated 15 per cent of the entire group lived five years after onset of disease.

The results of supervoltage radiation in the treatment of tumor of the bladder have received more attention in our clinic than any of the other groups, due largely to the high percentage of good immediate results. They were reported by Dresser and Rude in 1938 and by Colby in 1941. In 1942, Colby and Schulz again reviewed the cases treated up to that time, a total of 139 cases. Since then 57 patients have been treated. The present observations are based on a study of the two latter groups. All the cases were inoperable at the time super-

TABLE XI

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF BLADDER: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	14	24	22	29	23	26	28	18	184	
Survivals at end of										
6 months	12	13	17	22	14	14	14	7		62
12 months	6	11	9	17	10	10	7			42
18 months	6	5	6	10	8	5				29
24 months	4	3	4	5	6	0				16
36 months	3	3	3	4	3					14
48 months	3	2	2	3						11
60 months	2	2	1							8
72 months	2	0								5
84 months	1									(7)

voltage irradiation was undertaken. Many had had some other form of treatment (fulguration or radium implants) before or after external irradiation.

In the early years, the planned dose at the site of the tumor was about 5,000 r; a few cases received more than this. Later the dose was reduced to 3,000 r, the daily dose varying between 300 r and 400 r. As in other groups, no serious permanent skin damage occurred if the dose to a single field did not exceed 3,000 r. The maximum tolerance dose to the bladder and rectum seems to be between 3,000 r and 5,000 r. Nearly all cases receiving 3,000 r, or over, showed some evidence of bladder or rectal irritation, and about 10 per cent showed severe reactions. There were no post-irradiation strictures.

Thirty-five per cent of the cases showed marked local regression, either during treatment or soon afterwards. Relief from discomfort and bleeding was obtained in more than half the cases. Colby and Schulz found a small percentage (10 per cent) in whom the tumor seems to have been completely destroyed.

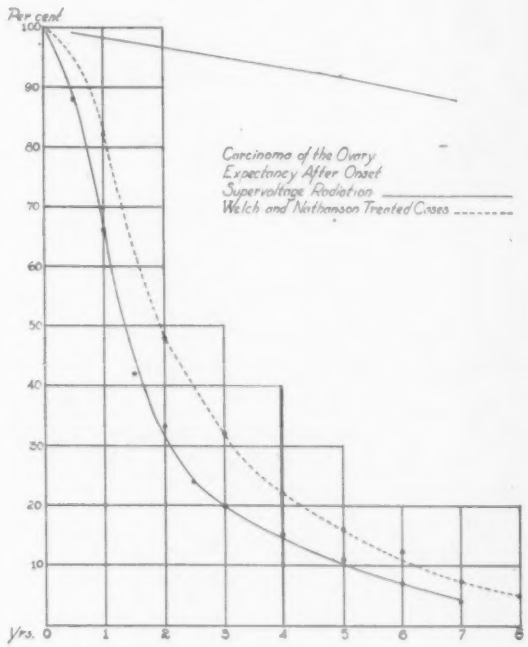
It is to be noted in Graph 11 that the life expectancy curve falls below that of Nathanson and Welch. This is due to the inclusion in their group of a considerable number of surgical cures. The five year survivals after supervoltage irradiation are about the same as those obtained with other methods. The data seem to show that supervoltage irradiation is an excellent palliative measure, that it prolongs life, and that in a small percentage of cases it results in a permanent cure.

Ovary

89 cases treated	76 cases analyzed
Average age 63 years	56 dead: 20 living
13 cases discarded	Average delay 9.2 months

A calculated 50 per cent of the entire group were dead sixteen months after onset of disease (Graph 12). Of those who had an opportunity to live five years after treatment, 16 per cent are known to have done so (Table XII), and a calculated 12 per cent of the entire group lived five years after onset of disease.

The radiation dosage varied considerably, but as a rule the estimated tumor dose was 3,000 r. In many cases, the tumor was distributed over large areas; at times the entire abdomen was involved, and in such cases, the treatment time was prolonged and the total dose limited. Roentgen

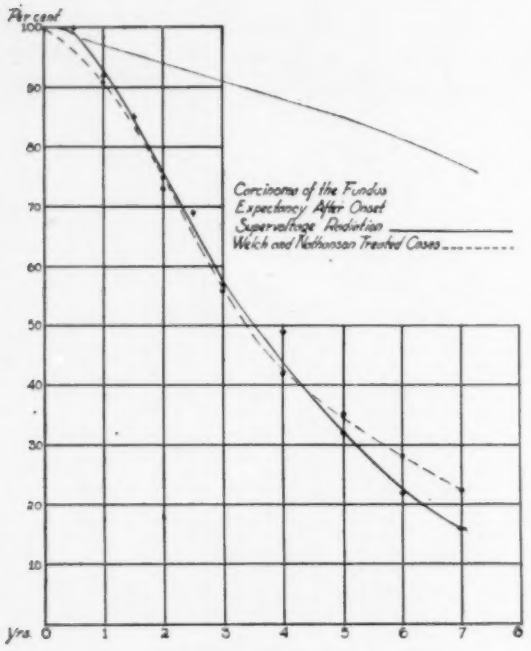


GRAPH 12.

sickness at times interfered with the progress of the treatment so that accurate estimation of the tumor dose was impossible.

A study of the available data indicates that although the majority of this group progressed rapidly to a fatal termination, a few cases showed striking improvement after irradiation, with definite prolongation of life over the usual expectancy. These favorable results appear to depend more on the character of the tumor than upon the kind or amount of radiation used. Table XII suggests that those cases that survive a full year are likely to live from three to five years. As yet we are unable to predict from

the histopathology or other data which cases will respond favorably. It has been somewhat easier to give an adequate dose with supervoltage radiation than with the older methods, and with it the patient suffers less discomfort. But there is insufficient evidence at the present time to justify transporting patients over long distances, away from homes and relatives, in order that they may receive supervoltage irradiation.



GRAPH 13.

Uterus

58 cases treated	49 cases analyzed
Average age 57 years	5 cases (10%) lost
9 cases discarded	23 dead: 21 living

Average delay 18.8 months

A calculated 50 per cent of the entire group were dead forty-six months after onset of disease (Graph 13). Of those who had an opportunity to live five years after treatment, 33 per cent have done so (Table XIII), and a calculated 32 per cent of the entire group lived five years after onset of disease.

Seven of the group had not been subjected to surgery. Of these, 5 are dead at two, ten, twenty, twenty-one, and thirty-seven months, and 2 are alive at thirty-six and forty-nine months after treatment respectively. Forty-two of the group had had previous surgical treatment, and irradiation was given either because the disease had recurred, or because at the time

TABLE XII

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF OVARY: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	4	5	9	7	13	15	12	11	76	
Survivals of end of										
6 months	3	4	6	3	5	10	7			58
12 months	1	1	5	1	4	6	5			35
18 months	1	1	5	0	4	4				28
24 months	1	1	5	0	4	2				25
30 months	1	1	4	0	4	1				21
36 months	1	1	4	0	3	1				19
48 months	1	1	4	0	1					18
60 months	1	1	4	0						16
72 months	1	1	2							(22)
84 months	1	1								(22)

TABLE XIII

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF UTERUS: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	3	1	11	6	9	6	8	5	49	
Survivals at end of										
6 months	2	1	10	5	8	4	6			82
12 months	1	1	10	5	8	3				78
18 months	1	1	10	5	8	2				73
24 months	1	1	9	4	8	2				69
30 months	1	1	8	4	7	2				64
36 months	1	0	8	4	3					53
48 months	0	0	6							40
60 months	0	0	5							33
72 months	0	0	0							0

of operation complete removal of the tumor could not be accomplished. The cases treated during the early years survived considerably longer than those treated at later dates. This may be due to the somewhat larger dosage used at that time (radium was not used routinely, and the roentgen dose was the same as that used in the treatment of carcinoma of the cervix.) The 5,000 r tumor dose seems to have been more effective than 3,000 r, but the number of cases treated each year is too small to warrant any definite conclusions. There were no serious irradiation injuries in this group.

It is of some interest that the cases which received supervoltage radiation only did not do quite as well as the group as a whole. The survival period in carcinoma of the uterus is longer than in carcinoma of the cervix, but this is to be expected because of the difference in the histopathology of the tumor. When comparison is made between the supervoltage radiation survival curves and those treated with other methods, it is apparent that the former show no notable improvement, but this also is to be expected in view of the fact that the treatment of choice in carcinoma of the uterus is surgical. The five year survival rate of 33 per cent, however, is too high, due to unusually good results in the year 1939. There are no six year survivals.

Cervix

424 cases treated	393 cases analyzed
Average age 50 years	42 cases (11%) lost
31 cases discarded	211 dead: 140 living

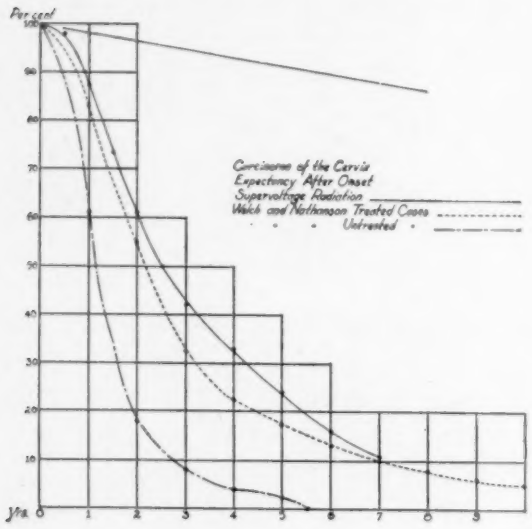
Average delay 9.7 months

A calculated 50 per cent of the entire group were dead thirty months after onset of disease (Graph 14). Of those who had an opportunity to survive five years after treatment, 26 per cent are known to have done so (Table XIV), and a calculated 24 per cent of the entire group lived five years after onset of disease.

Of the group analyzed, 286 received supervoltage radiation followed or preceded by the usual course of radium without other treatment. The remainder received other forms of radiation or surgery either preceding or following supervoltage irradiation. Many of the latter group were given supervoltage irradiation as a palliative measure only.

During the early years, the most favorable cases were treated with radium only and these are not included in this report

since it deals only with cases that received supervoltage radiation. During the later years, the more favorable cases were treated surgically, and they also are omitted from this study. The group reviewed is one in which any advantage or disadvantage of supervoltage radiation should appear. The lesion is deep seated, yet easily examined. In the irradiated field are other organs which, if injured by overdosage, will cause serious complications.



Graph 14.

The dosage varied somewhat during the years covered by this study. From 1938 to 1941, treatment was given through three fields, one anterior and two posterior, 3,000 r, measured in air, being given to each. The daily dose was 400 r; the estimated dose at the site of the tumor was 5,000 r. From 1942 to 1945, only two fields were used, the total dose to each field was 3,000 r, as in the early years, but the daily dose was reduced to 300 r. The estimated dose at the site of the tumor was 3,000 r. All cases received radium as well as roentgen treatment, the dosage being between 3,000 and 5,000 mg-hr. Usually supervoltage irradiation preceded the application of radium, but there was considerable variation from case to case.

In Graph 14, comparison of supervoltage radiation life expectancy curves in carcinoma of the cervix with those treated with 200 kv. radiation shows a definite increase in the percentage surviving more than one year. After five years, however, the two curves begin to run parallel. This could be

Table XIV

POST-TREATMENT SURVIVAL RATES IN CARCINOMA OF CERVIX: ANALYSIS BY YEARS IN WHICH SUPERVOLTAGE RADIATION WAS INSTITUTED

Year Treated	1937	1938	1939	1940	1941	1942	1943	1944	Total	Per Cent of Group Who Had Opportunity to Survive
Number Cases	23	54	74	59	60	50	41	32	393	
Survivals at end of										
6 months	20	50	66	52	52	39	34			89
12 months	15	39	56	33	43	32	25			69
18 months	11	30	48	29	38	23				56
24 months	8	25	39	22	33	17				45
30 months	8	24	36	21	26					43
36 months	7	21	32	18	21					37
48 months	5	18	26	14						30
60 months	3	13	23							26
72 months	3	8								14
84 months	2									8

interpreted as evidence of better palliative results. If one takes into consideration also the absence of severe skin damage and decrease in roentgen sickness, it would seem that the use of supervoltage radiation was worth while in this group. There were some ill effects, possibly due to overdosage, especially in the early years when larger combined roentgen and radium dosage was used. To avoid these complications, the estimated depth dose with roentgen rays was reduced; the radium dosage was not changed. In other pelvic lesions, there has been very little permanent damage to the ureters, bladder, or rectum where a depth dose of 5,000 r with roentgen rays alone has been given.

In comparing primary with secondary cases of carcinoma of the cervix, that is, those treated with supervoltage roentgen radiation and radium alone and those treated with additional or other forms of treatment, an interesting observation was noted. The secondary cases showed a higher survival rate after onset of disease, as is shown in the following table, as the years passed. Ferguson has made similar observations in his study of bone tumors.

COMPARISON OF PRIMARY AND SECONDARY CASES

Survival at	Treated with Supervoltage Roentgen Radiation and Radium Per cent	Multiple Therapy Per cent
6 mo.	99	97
12 mo.	87	88
18 mo.	73	74
24 mo.	59	62
30 mo.	47	55
36 mo.	39	45
48 mo.	28	37
60 mo.	19	28
72 mo.	11	21
84 mo.	6	16

These results should not be interpreted as indicating that multiple forms of ineffective treatment are desirable. It merely emphasizes the well known fact that patients with slowly growing tumors, who normally survive for a long time, are apt to receive a variety of treatments.

Twenty-eight patients were irradiated over functioning ovaries in order to produce premature cessation of the menses. The usual dose was less than 2,000 r, divided between opposing pelvic fields. Twenty-six of this group were treated because of metastatic tumor to the bone from carcinoma of the breast and 2 for control of endometriosis. So far as is known, menstruation did not begin again, and no skin change was evident in the irradiated areas. The results, however, were no better than those obtained with 200 kv. radiation.

Lymphoma

99 cases treated	83 cases analyzed
62 males: 37 females	7 cases (8%) lost
Average age 45 years	51 dead: 25 living
16 cases discarded	

This group included lymphoma of various kinds, Hodgkin's disease, lymphosarcoma, and leukemia. Of the dead, the average duration of disease was thirty-nine months, ranging from a few months to a maximum of 196 months. Among the living, the average duration is fifty-four months, with a maximum of 172 months.

In 15 instances, treatment was limited to supervoltage radiation. In this group, 6 are dead, with an average duration of life of thirteen months; 4 are alive with average duration of eighteen months. (Of the remainder, 3 were discarded and 2 were lost.) One of the living has survived ninety-six months and another forty-three months since onset of disease.

Although the general course of the disease does not seem to be notably altered, supervoltage radiation often permits radiation to be given over a long period of time without damage to the skin. It also permits, without evident permanent damage to overlying tissue, the giving of larger doses to deep-seated masses than is possible with low voltage. There is some evidence that a single lymphomatous mass can be completely destroyed by doses of 2,000 to 3,000 r.

Eight patients with leukemia are included in this group. The course of the disease was not notably altered as compared with other forms of radiation.

MISCELLANEOUS

A miscellaneous group of 257 cases, covering a wide variety of tumors and locations were treated. The size of each individual group was not large enough, or the results significant enough, to warrant detailed discussion.

In this group were 143 patients with *metastatic disease* from various tumors. In no case did the result differ to any appreciable extent from that obtained with lower voltage roentgen therapy.

Seven inoperable *carcinomas of the breast* received supervoltage irradiation to the primary lesion. All are dead, with an average duration after treatment of fourteen months. The group is too small for detailed analysis, but supervoltage radiation, in our experience, does not appear to offer any advantage over lower voltages. In view of the recent work of Phillips, however, further trial seems to be indicated.

In addition to the above, 107 cases suffering from a variety of benign or malignant tumors were treated. In this group, there were 23 varieties including such lesions as *carcinoma of the pancreas, adrenal tumor, chordoma, ependyoma, synovioma, fibrosarcoma, hemangioma, brain tumor, acromegaly, myasthenia gravis, carcinoma of the trachea,* of the *external auditory meatus,* of the *submaxillary gland,* of the *salivary gland,* of the *parotid gland,* of the *vagina,* of the *thyroid,* and *tumors of the bone.* The number of cases in each variety numbered under 15, and in one group only, bone tumors, were unusual or worth while results obtained.

Of the 14 bone tumors treated, 11 were *Ewing's tumor,* 2 were *osteogenic sarcoma,* and 1 was a *giant cell tumor.* Of the patients with malignant tumors, all are dead except 3 with Ewing's tumor, 1 male seventy-three months after treatment and 2 females fifteen and fifty-six months after treatment. The survival of a patient with histopathologically proved Ewing's tumor for five years or more is remarkable, and we believe should be reported briefly.

The first case is that of a twenty year old, single, white girl, who was admitted originally in January, 1941, complaining of a painful right ankle which had persisted since the previous June. Roentgen examination showed a lesion of the lower right fibula which was biopsied on January 23, 1941. Histopathologic diagnosis was Ewing's tumor. The patient refused further surgery, and in February, 1941, she was given supervoltage radiation covering the entire fibula, totaling 4,500 r. She has been well since, has been married, and was seen last in December, 1945, at which time she seemed to be free from disease. The skin shows little if any change; there is no limitation of motion in the ankle and no atrophy of the muscles. Roentgen examination shows residual deformity but no evidence of active tumor.

The second case is that of a five year old boy, first seen at the Collis P. Huntington Memorial Hospital in July, 1939. In May, 1939, he had been struck by an automobile, sustaining bruises about the head and face. One week later he developed a "cold," and a roentgenogram of the chest, taken at another hospital, showed fluid in the right pleural cavity and a destructive lesion involving the right ninth rib. The lesion of the rib was biopsied, and the slide made at that time has been repeatedly reviewed by different pathologists all of whom have agreed on the diagnosis of Ewing's tumor.

In July, 1939, supervoltage radiation was given at the rate of 100 r per day for a total of 3,300 r over the involved rib and right chest. There has been no recurrence of the tumor, and the patient has been well since. He has developed normally; there has been no evidence of metastases. He was last seen in September, 1945. Roentgen examination shows no evidence of active tumor.

The fact that with supervoltage radiation any involved bone can be adequately treated through a single large field with little or no permanent damage to the skin makes this form of treatment preferable in Ewing's tumor.

SUMMARY AND CONCLUSIONS

The results of eight years' work with supervoltage radiation, covering the period

from 1937 through 1944, inclusive, have been reviewed. A total of 1,835 cases with tumors, for the most part malignant, of various kinds and in various locations, have been so treated. The results have been analyzed as separate groups, where the numbers were large enough to make this justifiable, and have been compared with published results, when available, in similar groups treated with 200 kv. radiation and/or other methods, as well as untreated groups.

As was to be expected, it was found that deep-seated, localized lesions, which in the past have shown some response to high voltage radiation, have done better with supervoltage radiation, in that life has been prolonged and made more comfortable. There is very little evidence to show, however, that a greater number of these tumors can be destroyed by this method of treatment than is possible with other methods. It had been hoped that with supervoltage radiation it would be possible to destroy glandular metastases in cases in which the primary lesion had already been destroyed either by irradiation or surgery. This objective has not been accomplished. In selected cases, in which the tumors are proved to be radiosensitive, better results may be possible. Unfortunately, radiosensitive tumors are also rapidly growing ones, metastasizing early to distant organs, and only a few patients survive for any length of time.

Perhaps the most important advantage of supervoltage radiation is due to the fact that with it there is less likelihood of serious skin damage than with lower voltage radiation. It has been shown repeatedly that with supervoltage radiation, properly applied, it is possible to produce severe damage to deep-seated organs without permanent injury to the overlying skin. The total dose is no longer dependent upon skin tolerance but upon the reaction of the deep-seated organs in the path of the rays. In those cases where arrest of the disease is impossible and life expectancy is a matter of months, protection of the skin is of minor importance, but where there is a chance of cure, or where life may be considerably prolonged, the avoidance of permanent skin damage must be given a place of some importance in the plan of treatment.

The material here presented seems to show that when the cases are properly selected, supervoltage radiation offers the patient a slight, but definite, increase in life expectancy and that some of the unavoidable, bad effects of irradiation with lower voltage can be eliminated. The life expectancy curves in the various groups show that there is considerable variation during the first twenty-four months, but that after twenty-four months the curves run more or less parallel. This is to be expected in patients with incurable disease in the age groups under discussion. The early part of the curve is influenced by the rate of progress of the disease, while the later curve follows closely that of the normal life expectancy for the given age group. From the data available, it was impossible to determine the true cause of death in many cases, or to estimate the relative importance of the primary tumor and distant metastases in the final stages of the disease.

More information is necessary before final conclusions can be drawn but, in our opinion, the use of supervoltage radiation should be encouraged in selected cases of carcinoma of the cervix, carcinoma of the bladder, carcinoma of the lung, embryoma of the testicle, carcinoma of the tonsil, localized lymphoma, Ewing's tumor, and carcinoma of the rectum.

Massachusetts General Hospital
Boston, Mass.

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VOL. 55, NO. 5

THE MANAGEMENT OF MALIGNANT TUMORS OF THE TESTIS*

By EUGENE P. PENDERGRASS, M.D., GEORGE W. CHAMBERLIN, M.D., JOSEPH SELMAN,† M.D., *and* ROBERT C. HORN, JR., M.D.

PHILADELPHIA, PENNSYLVANIA

FOR several centuries, neoplasms of the testis have been described in the medical literature, but until the advent of modern radiotherapy the outlook for patients with these highly malignant tumors was almost universally hopeless. An extensive literature has developed on this subject in recent years, and a number of excellent papers [2, 3, 4, 8, 9, 15, 17, 20, 21] review the controversies as to pathogenesis, classification, therapy, and survival.

In 1941, Chamberlin and Jamison[7] reported 45 patients with malignant tumor of the testis, observed in the Department of Radiology at the Hospital of the University of Pennsylvania, from 1916 to 1938. Since that report, 10 additional patients with tumors of the testis have been seen, making a total of 55 observed in a period of twenty-nine years. This is in sharp contrast to the large number of testicular tumors that have recently been seen in the armed forces. Thus, at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, in September, 1944, two papers were read, based on 80 and on 65 cases respectively[12, 1] and a third discussed the urographic findings in a series of patients with testicular tumors.[4] This is undoubtedly due to the high degree of selection of the Army population on the basis of age and sex.

Our present study will reconsider the previously reported cases in the light of an additional three year period of follow-up. An attempt will be made to evaluate the various methods by which irradiation was given and to present our ideas on the relative merits of preoperative and postoperative roentgen therapy.

MATERIAL

This study includes 55 patients with the clinical diagnosis of tumor of the testis, seen in the Department of Radiology from 1916 to January, 1945. Pathologic material is available at present for re-study in 42 of these (Table I), of whom 33 are known to have had a malignant tumor. The other 9 cases re-studied will be referred to subsequently. In 10 other cases, the clinical course was typical of malignancy and in 3 of these, histopathologic diagnosis of malignant tumor had been made elsewhere (Table II). These 10 patients have therefore been included in our statistics. Thus our final statistics are based on 43 patients, all of whom are definitely known to have had malignant tumors.

In conformity with the growing tendency towards simplification, we have classified the tumors as either homologous or heterologous. The homologous tumors are composed of uniform cells without organoid arrangement, while the heterologous tumors are made up of a mixture of tissues showing various types and degrees of differentiation (Table III).

Among the 20 homologous tumors in this series, there were 13 characteristic seminomas (Fig. 1). All showed some degree of lymphoid infiltration of the stroma. Five of the tumors in this group had been almost completely destroyed by irradiation, but their nature could still be recognized by the "shadow cells" described by Dean.[8] In each of these 5 patients, small masses of shadow cells were surrounded by heavy capsules of fibrous tissue containing many phagocytes filled with lipoid material or blood pigment (Fig. 2).

* From the Departments of Radiology and Surgical Pathology, and the Penn Mutual Foundation for the Study of Neoplastic Disease, Hospital of the University of Pennsylvania, Philadelphia, Pa.

† Trainee of the National Cancer Institute in the Diagnosis and Treatment of Cancer.

TABLE I

SUMMARY OF PATIENTS ON WHOM PATHOLOGIC MATERIAL IS AVAILABLE (42 CASES)

Name	Age	Side	Duration	Metastases on Admission	Roentgen Treatment	Type of Tumor	Result (Time from Onset)
H.A.	24	R	2 mo.	0	Postoperative	Malignant teratoma	Died 15 mo.
T.B.	30	R	?	0	Postoperative	Seminoma	Living and well 13 yr.
N.R.	56	R	18 mo.	?	Postoperative	Seminoma	Living and well 14½ yr.
J.S.	31	R	15 mo.	?	Postoperative	Seminoma	Living and well 13 yr. (died, cause?)
I.B.	33	L	5 wk.	0	Postoperative	Malignant teratoma	Living and well 6 yr.
J.C.	51	L	?	0	Postoperative	Adult teratoma	Living and well 8 yr.
P.C.	66	R	5–6 yr.	0	Preoperative	No tumor. Atrophy of testis, fibrosis of rete and and epididymis	Living and well 11 yr. Had resection for carcinoma of sigmoid in 1939, resection of prostate for benign hypertrophy in 1944
E.D.	20	L	8 wk.	0	Preoperative	No tumor. Hematocele	Living and well 5yr.
H.E.	41	L	?	0	Preoperative	No tumor. Hematoma (possible tumor destroyed by irradiation)	Living and well 5 yr.
W.J.H.	26	L	2 yr.	0	Preoperative	No tumor. Hematoma (possible tumor destroyed by irradiation)	Living and well 5 yr.
R.M.K.	30	R	3 mo.	0	Postoperative	Seminoma	Living and well 9½ yr.
H.M.	24	R	2 wk.	0	Postoperative	Malignant teratoma	Living and well 11½ yr.
J.R.P.	28	R	5 mo.	0	Preoperative	Seminoma destroyed by irradiation; "shadow cells"	Living and well 7½ yr.
L.S.	57	L	15 yr.	0	Preoperative	Probable malignant change in adult teratoma (much cartilage and calcification)	Living and well 22 yr.
O.S.	45	L	3 mo.	0	Pre- and postoperative	No tumor. Hematoma (possible tumor destroyed by irradiation)	Living and well 5 yr. (Left upper quadrant mass treated by roentgen irradiation in 1939)
S.S.	28	R	2 mo.	0	Preoperative	Teratoma. Areas of necrosis resembling the seminoma	Living and well 5½ yr.
C.S.	33	R	6 wk.	0	Pre- and postoperative	Seminoma destroyed by irradiation; "shadow cells"	Living and well 10 yr.
A.S.	35	R	2 yr.	Right upper quadrant mass. ? Inguinal	Postoperative	Seminoma	Living and well 8 yr.
J.B.W.	56	R	1 yr.	0	Postoperative	Seminoma	Living and well 8½ yr.
N.W.	68	R	5 mo.	0	Preoperative	No tumor. Hematocele	Living and well 5½ yr.
L.C.W.	37	R	1 mo.	0	Preoperative	Seminoma destroyed by irradiation; "shadow cells"	Living and well 7 yr.
J.S.W.	30	R	9 mo.	0	Orchiectomy during treatment	Seminoma destroyed by irradiation; "shadow cells"	Living and well 12 yr.
F.W.B.	21	R	5 mo.	0	Preoperative	Atrophy and fibrosis. No evidence of tumor	Living and well 12 yr.
A.V.	47	R	5 wk.	0	Postoperative	Malignant teratoma	Living and well 8½ yr.
P.W.	34	R	2 yr.	0?	Postoperative	Seminoma	Living and well 4½ yr.
D.M.	31	R	7 mo.	0	Preoperative	Seminoma destroyed by irradiation	Living and well 8 yr.
V.M.	38	L (Inguinal testis)	?	0	Postoperative	Seminoma	Living and well 6 mo. +
E.P.	35	L	6 mo.	?	Preoperative; postoperative 8 mo. after orchiectomy	Seminoma	Died 23 mo.
N.S.	32	L	6 mo.	Lungs, mediastinum, retroperitoneum	Postoperative	Malignant teratoma	Died 7 mo.

Table I—*Continued*

Name	Age	Side	Duration	Metastases on Admission	Roentgen Treatment	Type of Tumor	Result (Time from Onset)
A.F.	42	R	4 mo.	0	Postoperative 18 mo. after orchiectomy Metastases present	Seminoma	Died 34 mo.
H.H.	33	L	5 mo.	Lungs, abdominal and supraclavicular	Pre- and postoperative	Malignant teratoma	Died 18 mo.
C.H.	28	R	12 mo.	0	Postoperative	Seminoma	Died 27 mo.
D.J.	29	L	2 yr.	Inguinal, dissection	Postoperative (11 mo. after orchiectomy)	Seminoma	Died 38 mo.
M.K.	36	L	4 yr.	Left upper quadrant	Preoperative	Malignant teratoma	Died 54 mo.
F.M.	69	R	5 wk.	0	Pre- and postoperative	Embryonal carcinoma	Died 8 mo.
A.McD.	24	R	1 mo.	Lungs, abdominal and cervical nodes	Postoperative (treated in 1920)	Malignant teratoma	Died 7 mo.
L.W.	64	R	2 mo.	Inguinal	Postoperative, small amount	Embryonal carcinoma	Died 18 mo.
C.K.	31	R	2½ mo.	0	Preoperative	Malignant teratoma	Died 18 mo.
J.B.	41	R	8 mo.	Pain in back	Postoperative	Malignant teratoma	Died 17 mo.
M.B.B.	26	L	3 mo.	0	Postoperative	Adult teratoma	Died 6¼ yr.; acute alcoholism
J.D.	26	L	6 mo.	Lungs, retroperitoneal region	Postoperative, small amount	Malignant teratoma	Died 16 mo.
F.B.	31	R	5 yr.	0	Postoperative	Seminoma	Died 6¼ yr.

Two homologous tumors did not have the histopathologic characteristics of the seminoma group. They were uniformly composed of smaller cells than those of the seminoma, grouped in solid masses without any lymphoid infiltration and with minimal amounts of stroma (Fig. 3). These 2 tumors occurred in older men (aged sixty-nine and sixty-four) and were fatal in nine and sixteen months respectively. We therefore believe that these atypical homologous tumors should be recognized as distinct from the more typical seminomas. We have classified them as embryonal carcinomas, but for the purpose of compiling our statistics, have grouped them with the seminomas. Unfortunately, our hormone studies are too incomplete to be of assistance in the pathologic interpretation of these tumors.

Only 2 seminomas and 2 teratomas were seen in patients beyond the age of fifty and all 4 are among the five year survivals.

Two of the 15 tumors classified as teratomas were considered adult in view of the absence of anaplasia in the available sections. At no time did the clinical course of either of these patients suggest malignancy, and they have not been included in our survival statistics. In 11 of these teratomas, the malignant changes involved epithelial elements (Fig. 4), whereas the remaining 2 appeared sarcomatous.

In 3 of the teratomas, there were areas

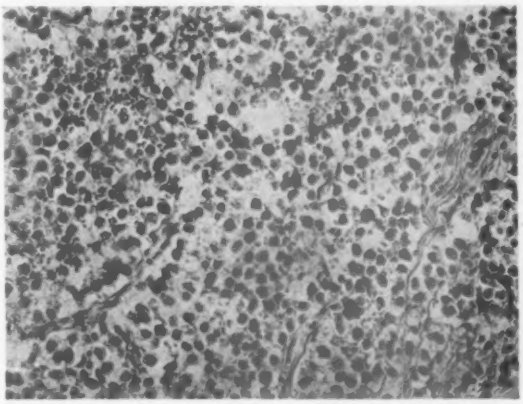

Fig. 1. Seminoma of testis. This section shows relatively little lymphoid infiltration (×300). Patient C. H., aged twenty-eight. Orchiectomy and postoperative irradiation. Died twenty-seven months after onset.

FIG. 2. Probable seminoma following preoperative irradiation. "Shadow cells" at right. The fibrous capsule shows a heavy deposit of blood pigment (×300). Patient J. R. P., aged twenty-eight, living and well seven and one-fourth years after onset.

closely resembling the seminomas. One of these tumors contained cartilage and foci of calcification. Except for these isolated observations, we have been unable to adduce evidence for either of the two conflicting theories of origin of the seminomas: seminal cell or one-sided development of a teratoma.

No instance of chorionepithelioma was found in this series.

All 7 patients in whom no histologic evidence of tumor was found had received intensive preoperative irradiation. It seems likely that 4 of these patients had malignant tumors which had been completely destroyed by the treatment (Fig. 5). Except for the absence of shadow cells, these lesions closely resembled those seminomas which had been similarly treated but could still be identified. However, the clinical findings, and course, taken in conjunction with pathologic findings, make it appear doubtful that the other 3 patients had malignant tumors at any time.

CLINICAL PICTURE

The clinical aspects of tumors of the testis have been thoroughly reviewed by a number of authors.[7,8,17,21] Their salient features will be brought out in the discussion of the findings in our patients.

The age incidence in the patients in this series is shown in Figure 6. It is seen that the peak incidence of the homologous tu-

TABLE II

SUMMARY OF PATIENTS ON WHOM PATHOLOGIC MATERIAL IS NOT AVAILABLE FOR RE-STUDY, BUT WHOSE CLINICAL COURSE VERIFIED THE INITIAL DIAGNOSIS OF MALIGNANT TUMOR (10 CASES)

Name	Age	Side	Duration	Metastases on Admission	Roentgen Treatment	Type of Tumor	(Result (time from onset)
E.B.	41	R	4 mo.	?	Postoperative	No material	Died 8 mo.
E.E.	20	L	?	+	Postoperative	No material	Died 1 + yr.
W.H.	27	–	?	+ Orchiectomy elsewhere 1 year before	Postoperative	No material	Died 2 + yr.
S.H.	57	L	4 mo.	+	Postoperative	No material	Died 15 mo.
J.L.	18	R	10 mo.	+	Preoperative (no orchiectomy)	No material	Died 10 mo.
C.T.M.	36	R	7 mo.	?	Postoperative	No material	Died 13 mo. +
A.M.	36	L	1 mo.	0	Postoperative	No material (diagnosed seminoma elsewhere)	Died 11 mo.
C.R.	27	R	2 mo.	0	Postoperative	No material (diagnosed adenocarcinoma elsewhere)	Died 12 mo.
E.A.S.	27	L	?	? (developed metastases later)	Postoperative	No material *(diagnosed embryonal carcinoma elsewhere)	Living and well 15 yr. +†
J. Lee	38	?	?	+	–	No material	Died 5 mo. +

* Diagnosis made by Dr. F. C. Wood, New York.

† This patient died with persisting retroperitoneal metastases and an independent carcinoma of the pancreas with pulmonary metastases.

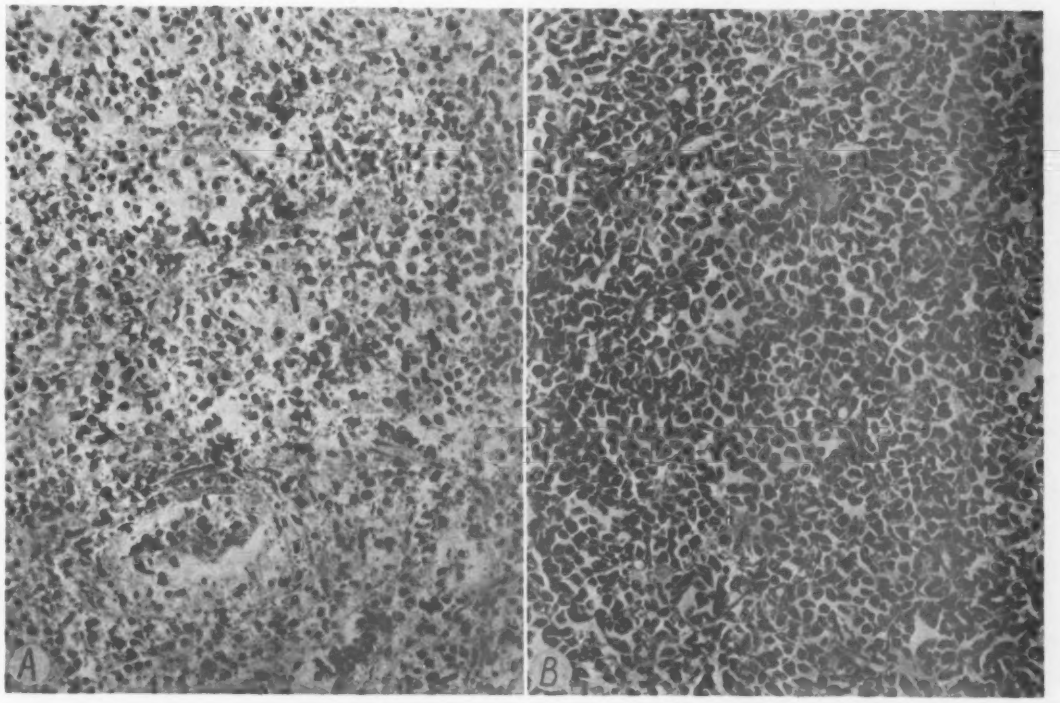

Fig. 3. *A*, embryonal carcinoma of testis (×300). Patient L. W., aged sixty-four. Orchiectomy and small amount of postoperative irradiation. Died eighteen months after onset. *B*, embryonal carcinoma (×300). Recurrent nodule along cord following preoperative irradiation of testis; also postoperative irradiation. Patient F. M., aged sixty-nine. Died eight months after onset.

mors (seminomas) occurred in the fourth decade, whereas the corresponding incidence of the heterologous tumors (malignant teratomas) was spread between the third and fourth decades. Seventy-four per cent of all the malignant testicular tumors occurred between the ages of twenty and

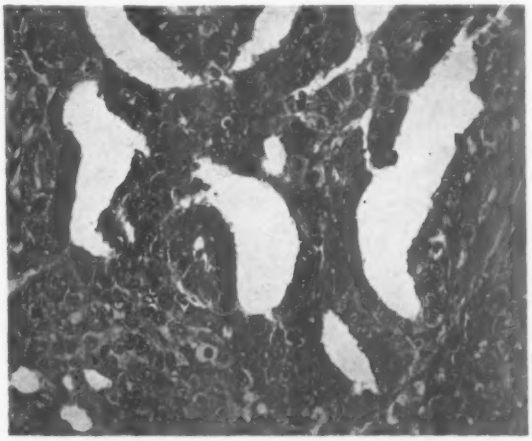

Fig. 4. Malignant teratoma of testis (×300). Patient C. K., aged thirty-one. Preoperative irradiation. Died eighteen months after onset.

Table III

PATHOLOGIC CLASSIFICATION OF THE CASES WITH MATERIAL AVAILABLE FOR RE-STUDY

	Number	Total
Homologous Tumors		20
Seminomas	18	
Embryonal carcinomas	2	
Heterologous Tumors		15
Malignant teratomas	13	
Adult teratomas	2	
Atrophy and fibrosis without evidence of tumor	2	7
Hematocele and hematoma without evidence of tumor	5	
		42*

* No tissue available now for re-study in 10 patients whose clinical course verified the initial diagnosis of malignant tumor; however, 3 of these studied elsewhere were diagnosed respectively as seminoma, adenocarcinoma and embryonal carcinoma.

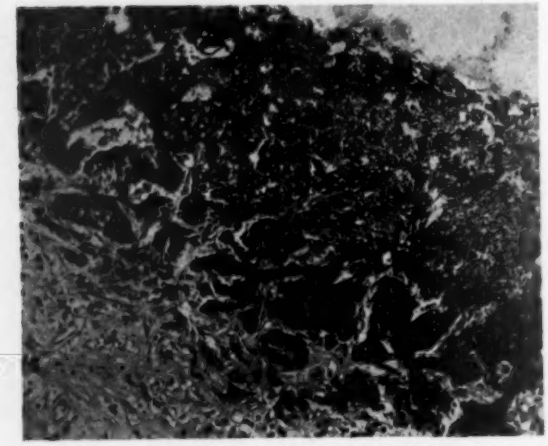

Fig. 5. Wall of hematoma of testis. No tumor cells or "shadow cells" (×300). Preoperative irradiation. It seems likely that this lesion represents a seminoma which was completely destroyed by irradiation, although histologic proof is lacking. Patient H. E., aged forty-one, living and well five years after onset.

thirty-nine, the age range of maximum sexual activity. These findings are in accord with those usually encountered in the literature.

In our patients the tumor occurred approximately twice as often on the right side as on the left. The ratio of right-sided preponderance is higher than that usually reported in the literature.

Trauma was mentioned as occurring in from two days to many years before the onset of tumor in 7 patients (17 per cent), a figure essentially in accord with that of Gilbert[13] who has pointed out that the incidence of trauma in testicular tumor is the same as in epididymitis and hydrocele without tumor, about 15 per cent.

The presenting symptoms in our patients are shown in Table IV.

The most frequent complaint on admission was a painless mass in the scrotum. However, one-third of the patients had testicular pain in addition to the mass. This was most often aching in character but in 2 instances it was described as being sharp. Two patients noted inguinal discomfort. In 3 instances, the mass was discovered on routine physical examination, the patient

Table IV

PRESENTING COMPLAINTS

Symptom	Number of Patients	Percentage of Total (43 cases)
Mass in testis	42	97
Pain in testis	15	35
Pain in lumbar region	6	14
Changes in breasts	6	14

having been unaware of its presence. Six patients complained of lumbar pain on admission, but in only 1 of these was it the initial symptom. We have come to regard lumbar pain as a symptom of ominous significance. In 9 of our patients who subsequently died, lumbar pain was a serious complaint. On admission, 1 patient called attention to masses in the left supraclavicular fossa and in the abdomen, but also complained of lumbar pain and scrotal swelling.

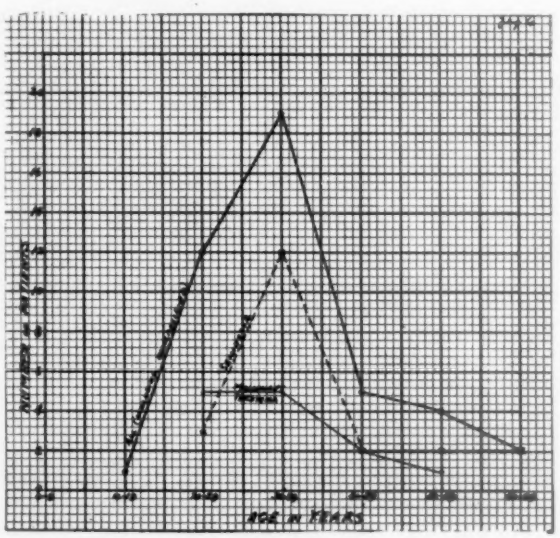

Fig. 6. Age distribution of patients with malignant tumors of the testis. Of the 43 patients, 74 per cent were in the age group twenty to thirty-nine. Of the seminomas (homologous tumors) 75 per cent, and of the malignant teratomas (heterologous tumors) 77 per cent were in this age group.

Despite the infrequency of symptoms re-

ferable to metastases on admission, 38 per cent of 37 patients on whom such data are available had objective clinical evidence of metastases when first examined in this hospital. In all, 58 per cent showed evidence of metastases at some time during their illness. Table v indicates the known sites of such lesions.

This distribution emphasizes the tendency of these tumors to spread first to the lymph nodes about the celiac axis by way of the lymphatics accompanying the spermatic vessels. These retroperitoneal metastases frequently give rise to abdominal cramps and gastrointestinal disturbances. It is interesting to note that such symptoms were present in 6 of our fatal cases, but in only 1 of our surviving group.

TABLE V

KNOWN SITES OF METASTASES

Site	Number of Patients	Percentage of Those Having Metastases
Retroperitoneal	19	80
Mediastinopulmonary	13	54
Supraclavicular	6	25
Inguinal	3	13
Bone (rib and femur)	2	8

Only 1 of the tumors in the present series developed in an undescended testis. This patient, who has recently completed treatment, had a seminoma in an inguinal testis. The remaining testis is in the scrotum.

Breast changes, including nodular or diffuse enlargement and pain, either unilateral or bilateral, were observed in 9 patients. In 6, the breast symptoms were present on admission. Hormone assays were done in 6 patients with breast symptoms, and 5 showed positive Friedman or Ferguson tests.

We have put particular reliance upon frequent roentgen examination of the chest and urinary tract in patients with malignant testicular tumors. In 13 patients, chest roentgenograms at some time during their course revealed pulmonary or mediastinal metastases. In 4, survey roentgenograms of the abdomen demonstrated obliteration of the psoas shadow by a soft tissue mass, and displacement of the renal shadow on that side. Excretory urographic studies are extremely valuable in revealing retroperitoneal metastases. In our series they showed either a non-functioning kidney, displacement of the ureter or kidney, or hydronephrosis due to ureteral obstruction in a total of 9 patients out of 19 so examined. These changes were always on the same side as the primary lesion. It is of interest to note that excretory urograms demonstrated metastases in 60 per cent of those patients who subsequently died. In addition, urographic studies serve as an index of the response of the metastatic lesions to irradiation. In several patients in whom there was roentgen evidence of disturbed renal function before roentgen therapy, return of function was observed in later roentgen studies after the irradiation had reduced the size of the metastatic masses around the renal pelvis.

Roentgen examination of the gastrointestinal tract may also be of importance in the diagnosis of metastatic disease. In several of our patients there was displacement of the stomach, duodenum, or colon.

Another procedure of importance is bioassay for urinary gonadotropic hormone excretion. Zondek[24] in 1930 first reported the excretion of this substance in patients with testicular tumor. The Ferguson[10,11] modification of the Aschheim-Zondek test early gave promise of close correlation with histopathologic structure, radiosensitivity, and prognosis. However, subsequent clinical observation has not borne this out. Hamburger, Bang and Nielsen[16] and Twombly, Temple and Dean[23] have reported improved correlation by testing not only quantitatively for the presence of hormone, but also qualitatively for the differentiation of follicle-stimulating and follicle-maturing fractions. Such studies should be carried out when the patient is first seen and before any form of therapy has been administered. Subsequent ex-

aminations can be employed in following the patient's course. A positive test appearing after treatment is significant if done within eight months of orchiectomy. Beyond that time, follicle-stimulating hormone may be indicative either of castration effect or of recurrence. A negative test has no significance, except insofar as the absence of chorionic (follicle-maturing) hormone improves the prognosis.[16] In our series, no correlation can be established between the results of bioassay and the patient's clinical course, chiefly because a variety of methods was employed and none of these attempted to differentiate the hormone fractions.

TREATMENT

What constitutes adequate therapy? The answer to this question is still controversial. At present, it is generally conceded that all patients with malignant testicular tumor should have the benefit of irradiation and orchiectomy. However, the method of application of such therapy is subject to wide difference of opinion, both as to technical factors and time relationship to orchiectomy. The radical operation of Hinman[18] with dissection of the regional lymphatics has not been generally accepted, and he, with others, now believes that it should be used only in selected cases where the tumor is known to be radioresistant and where there is no clinical evidence of metastasis.[19] None of our patients were subjected to this procedure.

In the past we have believed that the survival rate might be improved by administering deep roentgen treatment preoperatively to the lymphatic drainage areas of the testis and to the testis iteslf, followed by orchiectomy.[7] This was based, first of all, on the observation that in some instances, orchiectomy without preliminary irradiation was followed in many instances by rapid development of clinically evident metastases. In the second place, Russ and Scott[22] had shown a number of years ago in experimental animals that the spread of malignant neoplasms could be inhibited by irradiation of adjacent tissue. It was felt that preoperative irradiation might, in the sense of Russ and Scott, create in the distant lymphatics factors less favorable for the subsequent spread of metastases. This problem will be considered again later.

Our series includes patients treated either preoperatively or postoperatively, as well as a group which received both forms of treatment. The earliest patient in our series was admitted in 1916 and was subjected to roentgen and radium irradiation. It is well known that considerable evolution in therapeutic methods has occurred since that time. As a basis for comparison, we have considered the following technical factors as constituting "conventional" treatment *during the period of this report:* 190 or 200 kv., 0.5 mm. Cu or 1 mm. Cu plus 1 mm. Al filtration, 50 cm. or 80 cm. target-skin distance, the total dosage being at least 800 roentgens in air applied to the mid-abdomen either anteriorly or posteriorly and extending 10 cm. to each side of the midline. However, in our more recent cases, as much as 1,600 r was given to abdominal fields anteriorly and posteriorly, and in some, the mediastinal and left supraclavicular regions were also included. In patients receiving preoperative irradiation, at least 1,000 r delivered to the testis is considered "conventional." In those instances in which treatment was given prior to the establishment of the roentgen as the unit of dosage, an approximate conversion of milliampere-minutes to roentgens has been employed.[7] In a few of the early cases, roentgen therapy was supplemented by radium pack. In all, 30 patients in our series have had what we consider conventional therapy, and of these, 28 have been followed for five years or more after orchiectomy.

During irradiation, every patient should have a weekly leukocyte count and hemoglobin determination, since the extensive irradiation depresses hemopoiesis, particularly affecting the leukocytes. In our series, the average fall in leukocyte count

was 3,310 from normal levels, occurring two to three weeks after the institution of treatment. In 50 per cent of patients, the leukocyte count fell below 2,500. However, in every instance there was a return to normal in about one month. Interestingly enough, in 4 instances, the leukocyte count returned to normal even while treatment was in progress. The present tendency in this department is to avoid depression of the leukocyte count below 1,000, but if further therapy is indicated, it may be resumed after a two or three week rest period.

A careful record of the patient's weight should be kept. Progressive loss of weight is often associated with a poor prognosis. Thus, in 9 of our fatal cases in whom the weight was followed, the average loss was 18 pounds in 3.5 months. Only 1 patient in this group maintained his weight. Although several of the surviving patients lost weight during the course of therapy, in most instances there was slight to moderate gain. It is evident that weight loss during therapy is no indication for interrupting the treatment, but every effort should be made to encourage an adequate dietary intake.

RESULTS

Of the patients receiving conventional therapy, 6 were treated before orchiectomy and 17 after orchiectomy. Of the latter group, 15 have been followed for a period of at least five years after orchiectomy. A third group of 7 patients received both preoperative and postoperative roentgen therapy, but it should be pointed out that in each case both courses of treatment were conventional.

We have chosen "five year survival" to indicate that the patient is alive and free from clinical evidence of metastasis or recurrence at least five years after orchiectomy. That this is a good indication of prognosis is evident from Table VI, where it is seen that all patients known to have died of their disease, succumbed within three years, and more than 50 per cent of these died within one year.

No definite correlation can be made between the age of the patient and the five year survival rate (Table VII). The difference in survival rate in the various age groups is too small to be of statistical significance.

The statement is frequently made that the homologous tumors (seminomas) offer

TABLE VI

LENGTH OF SURVIVAL OF 40 PATIENTS (ON WHOM SUFFICIENT DATA ARE AVAILABLE) WITH MALIGNANT TESTICULAR TUMORS, AFTER ORCHIECTOMY

	Total Number	Less than 1 Year	1 to 2 Years	2 to 3 Years	3 to 4 Years	4 to 5 Years	5 to 8 Years	8 to 10 Years	More than 10 Years
Living	19	1	—	1	—	—	8	4	5
Dead	21	11	7	2	—	—	—	—	1*

* Cause of death unknown in this patient.

TABLE VII

FIVE YEAR SURVIVAL IN VARIOUS AGE GROUPS. NO DEMONSTRABLE METASTASES ON ADMISSION. CONVENTIONAL TREATMENT

Age Groups	No. of Patients	No. of Five Year Survivals	Percentage of Five Year Survivals
20–29	4	3	75
30–39	11	7	64
40–49	2	2	100
50–59	3	3	100
60–69	1	0	0

a distinctly better prognosis than the heterologous type (malignant teratomas). Cabot and Berkson[6] found that the five year survival rate in patients free from metastases on admission was 75 per cent for the seminomas and 37 per cent for the carcinomas (corresponding to our heterologous tumors), a ratio of approximately 2 to 1.

TABLE VIII

FIVE YEAR SURVIVAL IN PATIENTS FREE FROM DEMONSTRABLE METASTASES ON ADMISSION, AND RECEIVING CONVENTIONAL THERAPY. COMPUTED FROM DATE OF ORCHIECTOMY

Pathology	Patients	No. of Five Year Survivals	Percentage of Five Year Survivals
Homologous	14*	9	54
Heterologous	6	5	83
Unclassified	1	1	100
Total	21	15	71

* Not included are 2 additional patients living and well at six months and at three years.

In our patients, free from demonstrable metastases on admission and receiving conventional therapy (Table VIII) no statistically significant difference can be demonstrated in the five year survival of patients with homologous and heterologous tumors. However, reference to Table IX reveals that 1 patient with a homologous tumor having metastases on admission is alive and well five years after orchiectomy, while no patient with a heterologous tumor with metastases on entry survived. Two patients with heterologous tumors developed metastases later, and both died of their disease. On the other hand, 1 patient with a homologous tumor developed supraclavicular and retroperitoneal metastases subsequent to admission, and he is alive and well eleven years after his last course of treatment. This evidence suggests a greater degree of sensitivity of the homologous testicular neoplasms as compared with the heterologous type, and is strengthened by the more destructive histopathologic changes produced in the former by equivalent amounts of radiation.

TABLE IX

FIVE YEAR SURVIVAL IN ALL PATIENTS WITH METASTASES ON ADMISSION RECEIVING CONVENTIONAL THERAPY. COMPUTED FROM DATE OF ORCHIECTOMY

Pathology	No. of Patients	No. of Five Year Survivals	Percentage of Five Year Survivals
Homologous	1	1	100
Heterologous	5	0	0
Unclassified	1	1	100
Total	7	2	30

Reference to Table X shows that in patients receiving conventional treatment, the five year survival rate in the group having metastases on admission is less than one-half that in the group free from demonstrable metastases. One patient without demonstrable metastases on entry survived despite treatment that was less than conventional, but of 9 patients with metastases on admission and receiving less than conventional therapy, not one survived five years. Furthermore, patients who never, throughout their course, developed clinical signs of secondary deposits had a five year survival rate of 93 per cent as against 29 per cent for those having such findings either on admission or later. The latter figure includes 4 patients with metastases who are living and well from five to sixteen years after onset of their disease (five to thirteen years after orchiectomy). Thus, the presence of metastases profoundly alters the prognosis, but by no means makes it hopeless, provided the lesion is radiosensitive and receives an amount of radiation approaching our conventional dosage and distribution. On the other hand, if a metastasis develops in a previously irradiated area, the prognosis is almost hopeless. We have had 9 such patients and all but one have died. Further

data on the survival of patients clinically free from metastases on admission are presented in Table XI.

On the basis of the foregoing data, we have come to the conclusion that the most important factors in survival appear to be the histopathologic classification of the neoplasm, the presence or absence of metastases, and well planned radiotherapy. In addition, the patient's own inherent resistance to the neoplasm undoubtedly plays a rôle, but this is a factor which is difficult to ascertain.

As has already been indicated, there is no agreement as to the time, relative to orchiectomy, when therapy should be instituted. We have divided our conventionally treated cases into three groups: (1) preoperative irradiation alone, (2) postoperative irradiation alone, instituted within four to six weeks after orchiectomy, and (3) combined preoperative and postoperative treatment. The patients in these groups are presented in detail in Table XII. The remaining patients in our series, receiving less than conventional treatment, are considered in Table XIII; it should be noted that only 1 of these patients survived more than five years, the rest dying of their disease within thirty months.

The data from Table XII have been condensed in Table XIV, omitting the 2 patients who have been followed for less than five years. It is evident that the five year survival rates in the three groups are essentially similar. The various pathologic types are represented in each treatment group. The age of the patients and the duration of the disease prior to treatment do not differ significantly in these groups. It should be noted that there were more than twice as many patients with metastases on admission in the postoperative group than in the preoperative (Table XII). Furthermore, Table XV discloses no significantly different rate of appearance of metastases in the preoperative and postoperative series. One of 5 patients with metastases on admission treated postoperatively is alive and well fourteen years

TABLE X

INFLUENCE ON FIVE YEAR SURVIVAL RATE OF PRESENCE OF METASTASES ON ADMISSION

Status	Treatment	No. of Patients	Five Year Survival	
			Number	Per cent
Without demonstrable metastases on admission	Conventional	21	15	71
	Less than conventional	4	1	25
With metastases on admission	Conventional	7	2	30
	Less than conventional	9	0	0

TABLE XI

ANALYSIS OF SURVIVAL OF 23 PATIENTS WITHOUT CLINICALLY EVIDENT METASTASES WHEN FIRST SEEN, RECEIVING CONVENTIONAL THERAPY

	Total No.	Less than 1 Year	1 to 2 Years	2 to 3 Years	3 to 4 Years	4 to 5 Years	5 to 8 Years	8 to 10 Years	More than 10 Years
Living	17	1	—	1	—	—	8	3	4
Dead	6	2	4	—	—	—	—	—	—

TABLE

PATIENTS RECEIVING

Pathology		Name	Age	Date of Admission	Metastases on Admission						
					Present or absent	How demonstrated					
						Symptoms or palpation	Roentgenography				
							Chest	Abdomen	Urogram	Gastro-intestinal Tract	Bone
PREOPERATIVE IRRADIATION	Homologous	L.C.W.	37	1932	Absent	Negative	Negative				
		J.R.P.	28	1936	Absent	Negative	Negative				
		D.M.	31	1936	Absent	Negative	Negative				
	Heterologous	C.K.	31	1940	Absent	Negative	Negative		Negative		Negative
		S.S.	28	1938	Absent	Negative	Negative		Negative		
		M.K.	36	1936	Present	Positive	Negative	Positive	Positive	Positive	
	Unclassified	E.D.	38	1938	Absent	Negative	Negative		Negative		
	?	W.J.H.	26	1939	Absent	Negative	Negative		Negative		
		E.L.G.	39	1934	Absent	Negative	Negative				
		H.E.	41	1938	Absent	Negative	Negative				
POSTOPERATIVE IRRADIATION	Homologous	V.M.	38	1944	Absent	Negative	Negative	Negative	Negative		
		F.B.	31	1934	Absent	Negative	Negative				
		C.H.	28	1931	Absent	Negative	Negative				
		A.M.	36	1940	Absent	Negative	Negative	Negative			
		R.M.K.	30	1934	Absent	Negative	Negative				
		*A.S.	35	1937	Present	Positive	Negative				
		J.B.W.	56	1934	Absent	Negative	Negative				
		*P.W.	34	1941	Absent	Negative	Negative	Negative			
		T.B.	36	1921	Absent	?Inguinal	Negative				
		N.R.	56	1928	Absent	Negative	Negative				
	Heterologous	**C.M.R.	27	1942	Present	Positive	Negative		Negative		
		*N.J.S.	32	1937	Present	Positive	Positive	Positive	Positive		Negative
		I.L.B.	33	1938	Absent	Negative	Negative		Negative		
		H.E.M.	24	1931	Absent	Negative	Negative				
		A.V.	47	1932	Absent	Negative	Negative				
		J.T.B.	41	1941	?Present	?Positive	Negative		Negative		Negative
	Unclassified	*E.A.S.	27	1930	Present	Positive		Positive			
PRE- AND POSTOPERATIVE IRRADIATION	Homologous	F.M.	69	1937	Absent	Negative	Negative	Negative	Negative		
		†E.J.P.	35	1941	Absent	Negative	Negative				
		J.S.W.	30	1932	Absent	Negative	Negative				
		C.S.	33	1932	Absent	Negative	Negative				
	Heterologous	H.H.H.	33	1939	?Present	?Positive		?Positive			
		L.S.	57	1936	Absent	Negative					
	Unclassified	O.S.	45	1938	Absent	Negative	Negative		Negative		

* Orchiectomy before admission.
** Bilateral orchiectomy.
† Supraclavicular metastases 8 mo. after onset.
§ Refer to second footnote, Table II.

XII

CONVENTIONAL THERAPY

Metastases after Orchiectomy								Survival after orchiectomy	Survival after stated onset	Survival after last treatment	Status when last heard from
Present or absent	Time of appearance after orchiectomy	How demonstrated									
		Symptoms or palpation	Roentgenography								
			Chest	Abdomen	Urogram	Gastrointestinal Tract	Bone				
Absent	None	Negative	Negative					7 yr.	7 yr.	7 yr.	Living and well
Absent	None	Negative						7 yr.	7 yr.	7 yr.	Living and well
Absent	None	Negative	Negative					8 yr.	9 yr.	8 yr.	Living and well
Present	4 mo.	Positive	Negative		Negative			1 yr.	1½ yr.	1½ yr.	Dead
Absent	None	Negative	Negative		Negative			5 yr.	5½ yr.	5 yr.	Living and well
Present								No orchiectomy	4½ yr.	½ yr.	Dead
No orchiectomy											
Absent	None	Negative						5 yr.	5 yr.	5 yr.	Living and well
Absent	None	Negative	Negative		Negative			3 yr.	5 yr.	3 yr.	Living and well
Absent	None	Negative	Negative					7 yr.	7 yr.	7 yr.	Living and well
Absent	None	Negative	Negative					4½ yr.	4½ yr.	4½ yr.	Living and well
Absent	None	Negative	Negative					6 mo.	?	4 mo.	Living and well
Present	3 mo.	Positive	Negative				Positive	1½ yr.	6 yr.	4 mo.	Dead
Absent		Negative	Negative					1½ yr.	2½ yr.	9 mo.	Dead
Present	6 mo.	Positive	Positive		Positive		Positive	11 mo.	11 mo.	1 mo.	Dead
Absent	None	Negative	Negative		Negative			9½ yr.	9½ yr.	8½ yr.	Living and well
Present	2 mo.	Positive	Negative		Positive and negative			6 yr.	8 yr.	6 yr.	Living and well
Absent	None	Negative	Negative					8½ yr.	?	8 yr.	Living and well
Absent	None		Negative		Negative			3 yr.	4½ yr.	2½ yr.	Living and well
Absent	None							12½ yr.	?	12 yr.	Living and well
Present	8 mo.	Positive (laparotomy)		Negative		Positive		13 yr.	14½ yr.	11½ yr.	Living and well
Present	Before	Positive	Negative					10 mo.	1 yr.	7 mo.	Dead
Present	Before							2 mo.	7 mo.	Coincidental	Dead
Absent	None	Negative	Negative		Negative			6 yr.	6 yr.	6 yr.	Living and well
Absent	None	Negative	Negative					11½ yr.	11½ yr.	11½ yr.	Living and well
Absent	None	Negative	Negative					8 yr.	8 yr.	8 yr.	Living and well
Present	3 mo.	Positive	Positive		Positive			9 mo.	1½ yr.	6 mo.	Dead
Present	Before	Positive (laparotomy)	Negative					16 yr.	?	13 yr.	Living and well§
Present	4 mo.	Positive	Positive		Positive			5 mo.	8 mo.	1 mo.	Dead
Present	2 mo.	Positive	Positive		Negative			1½ yr.	2 yr.	4 mo.	Dead
Absent	None	Negative	Negative					11 yr.	12 yr.	11 yr.	Living and well
Absent	None	Negative	Negative					10 yr.	10 yr.	10 yr.	Living and well
Present	?Before		Positive		Positive			10 mo.	1½ yr.	3 mo.	Dead
Absent	None	Negative	Negative					7 yr.	22 yr.	7 yr.	Living and well
Present	1 mo.	Positive	Negative		Positive and negative			5½ yr.	6 yr.	4½ yr.	Living and well

TABLE

PATIENTS RECEIVING LESS THAN

	Pathology	Name	Age	Date of Admission	Metastases on Admission						
					Present or absent	How demonstrated					
						Symptoms or palpation	Roentgenography				
							Chest	Abdomen	Urogram	Gastro-intestinal Tract	Bone
Preoperative irradiation	Unclassified	J.L.	18	1932	Present	Positive					
Postoperative irradiation	Homologous	D.C.J.	29	1925	Present	Positive					
		J.S.	31	1923	Absent	Negative	Negative				
		L.W.	64	1930	Present	Positive					
		S.H.	57	1916	Present	Positive					
		A.J.F.	42	1938	Present	Positive	Negative		Positive		Negative
	Heterologous	A.N.M.	24	1920	Present	Negative	Positive				
		J.M.D.	26	1928	Absent	Negative	Negative				
		H.A.	24	1932	Absent	Negative					
	Unclassified	E.B.	41	1940	Absent	Negative					
		C.T.M.	36	1916	?						
		E.E.	20	1929	Present	Positive	Positive				
		W.H.	27	1941	Present	Positive	Positive		Negative		
Relation to surgery unknown	Unclassified	J.Lee	38	1921	Present		Positive				

after exploratory laparotomy had revealed inoperable retroperitoneal metastases. This patient was able to obtain a life insurance policy ten years after orchiectomy.* A second postoperatively treated patient is living and well six years after orchiectomy, although he had retroperitoneal and inguinal masses. The remaining 3 patients died within seventeen months.

If we were to include in the preoperative group the 4 patients who had clinical evidence of testicular neoplasm, but in whom histopathologic proof is lacking, the five year survival rate in this group would be raised to 80 per cent, but this does not differ from the five year survival rate in the postoperatively treated group by a statistically significant amount. However, these 4 patients cannot be included with certainty because irradiation has so altered the structure of the testis that one cannot positively state that a malignant tumor was present.

Among the patients receiving both preoperative and postoperative irradiation, there were 3 in whom metastases developed after the first course of therapy. Only 1 of

* Since this report was submitted for publication, this patient died and came to autopsy. Viable tumor, metastatic from the testicular tumor, was found in the retroperitoneal region, but the primary disease was an apparently independent carcinoma of the pancreas with pulmonary metastases. The pancreatic and retroperitoneal tumor were histologically different.

XIII

CONVENTIONAL TREATMENT

Metastases after Orchiectomy								Survival after orchiectomy	Survival after stated onset	Survival after last treatment	Present status
Present or absent	Time of appearance after orchiectomy	How demonstrated: Symptoms or palpation	Roentgenography: Chest	Abdomen	Urogram	Gastrointestinal Tract	Bone				
Present	No orchiectomy	Positive						No orchiectomy	10 mo.	10 mo.	Dead
Present	?	Positive						14 mo.	38 mo.	During	Dead
?	?							5+yr.	?	?	Dead
Present	Before	Positive	Negative				Negative	16 mo.	18 mo.	4 mo.	Dead
Present	?	Positive						12 mo.	15 mo.	3 mo.	Dead
Present	6 mo.	Positive	Positive		Positive			30 mo.	33 mo.	3 mo.	Dead
Present	Present before	Positive	Positive					19 mo.	?	4 mo.	Dead
Present	2 mo.	Positive	Positive					9 mo.	15 mo.	4 mo.	Dead
Present	5 mo.	Positive					Negative	13 mo.	15 mo.	7 mo.	Dead
Present	2 mo.	Positive	Positive		Positive			5 mo.	9 mo.	3 mo.	Dead
Present	?	Positive	Positive					?	?	?	Dead
Present	?	Positive	Positive					12 mo.	?	1 mo.	Dead
Present	2 yr.	Positive	Positive		Negative			24 mo.	?	1 mo.	Dead
Present	?			Positive at time of orchiectomy				5 mo.	?	?	Dead

these was saved by postoperative irradiation. It is therefore reasonable to consider these instances as failures of preoperative treatment.

The overall end-result in our series of 43 patients with malignant testicular tumor is shown in Table XVI. It should be noted that these data are tabulated without regard to form of treatment or presence of metastases.

The five-year survival rate of 42 per cent in the entire series should be contrasted with the 71 per cent five year survival rate in the selected group presented in Table VIII; that is, in those patients free from demonstrable metastases on admission and receiving conventional therapy.

COMMENT

It has been shown that in our series there is no significant difference in the five year end-result, in the groups receiving preoperative or postoperative irradiation, provided the intensity and distribution of the treatment corresponds to our conventional procedure. However, it must not be assumed that the same relationship would hold true in a larger series of cases, although all the evidence obtained from the study of our case histories fails to disclose any particular advantage of preoperative over postoperative radiation therapy.

One of the chief objections to preoperative radiation treatment in these patients has been the destruction of the involved

TABLE XIV

SUMMARY OF END-RESULTS IN ALL PATIENTS FOLLOWED FIVE YEARS OR MORE, RECEIVING CONVENTIONAL THERAPY, AND HAVING DEFINITE EVIDENCE OF MALIGNANT TESTICULAR TUMOR

Treatment	Pathology	No. of Patients	Five Year Survivals		
			Number	Per cent	Entire group
Preoperative (A)	Homologous	3	3	100	67%
	Heterologous	3	1	33	
	Unclassified				
	All	6	4	67	
Postoperative (B)	Homologous	8	5	62	60%
	Heterologous	6	3	50	
	Unclassified	1	1	100	
	All	15	9	60	
Combined pre- and post-operative (C)	Homologous	4	2	50	57%
	Heterologous	2	1	50	
	Unclassified	1	1	100	
	All	7	4	57	
Preoperative and combined pre- and postoperative (A+C)	Homologous	7	5	71	62%
	Heterologous	5	2	40	
	Unclassified	1	1	100	
	All	13	8	62	
(A+C)+four cases of uncertain malignancy	Homologous	11	9	82	70%
	Heterologous	5	2	40	
	Unclassified	1	1	100	
	All	17	12	70	

testis to such a degree that subsequently no tumor can be demonstrated on microscopic study. This frequently introduces an element of doubt in the mind of the observer, especially if there is an absence of demonstrable metastases. In our series, 4 patients had to be eliminated for this reason. Another objection to preoperative irradiation is that a certain number of patients will be treated intensively for benign lesions. One of the authors (E.P.P.) believes, however, that serious consideration should continue to be given to preoperative irradiation. If there is any validity to the theories that the lymphatics and other tissues can be rendered less fertile by irradiation for the growth of metastases,[22] and that the presence of the "mother" tumor might inhibit the evolution of secondary growths,[7] it is advisable to continue administering preoperative irradiation on the basis of clinical diagnosis alone, until a sufficient experience has been obtained to evaluate more adequately the efficacy of this procedure. Irradiation of the primary tumor does alter its cellular structure and thereby renders the microscopic diagnosis more difficult. To overcome this objectionable feature, preoperative irradiation of the primary tumor might be reduced in amount or discontinued altogether.

In a previous communication[7] the authors were convinced that preoperative

TABLE XV

COMPARISON OF PREOPERATIVE AND POSTOPERATIVE IRRADIATION WITH REGARD TO APPEARANCE OF METASTASES AFTER ORCHIECTOMY, IN PATIENTS RECEIVING CONVENTIONAL TREATMENT, FOLLOWED FIVE YEARS OR MORE

	No Metastases on Admission	Preoperative Roentgenograms	Metastases after Orchiectomy		Status of Those Developing Metastases	Five Year Survival among Patients Developing Metastases after Orchiectomy
			Number	Per cent		
(A) Preoperative						
Certain malignancy	5	Chest	1	20	1 dead	None out of 1
Uncertain malignancy	4	Chest	0	0	—	—
(B) Postoperative	10	Chest Urogram in 2 cases. (One urogram became positive for metastases postoperatively)	3	30	2 dead 1 living and well	1 out of 3
(C) Pre- and postoperative	6	Chest in most cases. (One urogram, negative preoperatively, became positive for metastases postoperatively)	3	50	2 dead 1 living and well	1 out of 3
SUMMATION of (A) and (C)	11		4	36	3 dead 1 living and well	1 out of 4

irradiation offered the greatest opportunity for cure in the treatment of testicular tumors. The superiority of that method over postoperative radiation therapy is not definitely borne out in this study, as the results in five year survivals are approximately the same in both groups. The group reported here is small, however, and, it is quite possible that insufficient radiation is being employed. This has led us to conclude that radiation therapists should continue their efforts preoperatively as well as postoperatively.

In the absence of clinical metastases, we suggest the following plan of preoperative treatment. The factors are 200 kv., 15 ma., 0.5 mm. Cu plus 1 mm. Al, 80 cm. target-skin distance. The half-value layer is 0.9 mm. Cu. The fields are planned so that the lymphatic drainage channels of the torso on either side of the midline of the body from the supraclavicular regions to the symphysis pubis, and the inguinal regions and pelvis are irradiated (Fig. 7). The portals should extent at least 10 cm. to either side of the midline. The irradiation is started in the peripheral fields, and on successive days the treatment is directed over the adjacent fields. For instance, the first day, irradiation is given over field 1, the second over field 2, the third over field 3. When treatment of all of the fields has been completed, the fields are again treated

TABLE XVI

END-RESULT IN 43 PATIENTS WITH MALIGNANT TUMOR OF THE TESTIS, COMPUTED FROM TIME OF ORCHIECTOMY

Total number of patients living	19 (44%)
Number of patients living 5 years or more	18 (42%)

in the same order. The daily increments and the number of fields treated in one day should depend on the ability of the patient to tolerate the radiation. Each field should receive a total dose of 1,600 roentgens in air.

If treatment is to be applied to the primary tumor, it should not be started until all of the other fields have received at least 1,000 roentgens. The uninvolved testicle should be protected as much as possible from primary and secondary radiation by means of a lead cup. The amount of radiation applied to the involved testicle will depend on whether one wishes to destroy the tumor, which will require considerable irradiation, or merely modify its cellular appearance which can be accomplished readily by 1,000 roentgens.

The operation can be carried out at any time following completion of the roentgen therapy, either immediately or after a delay of a few days to three weeks. It seems to us that a simple orchiectomy is to be preferred to a more radical procedure.

If the patient has clinical evidence of metastases, irradiation in that area should be carried to the limit of skin tolerance. Wherever 400 or 1,000 kilovolt therapy is available, it may be beneficial to use such therapy, if the metastatic lesions do not respond to 200 kilovolt therapy.

Combined postoperative and preoperative radiation therapy should be employed in those patients who show clinical evidence of metastases either before or after operation. In such instances postoperative therapy should be directed largely over the fields that cover the metastatic lesions.

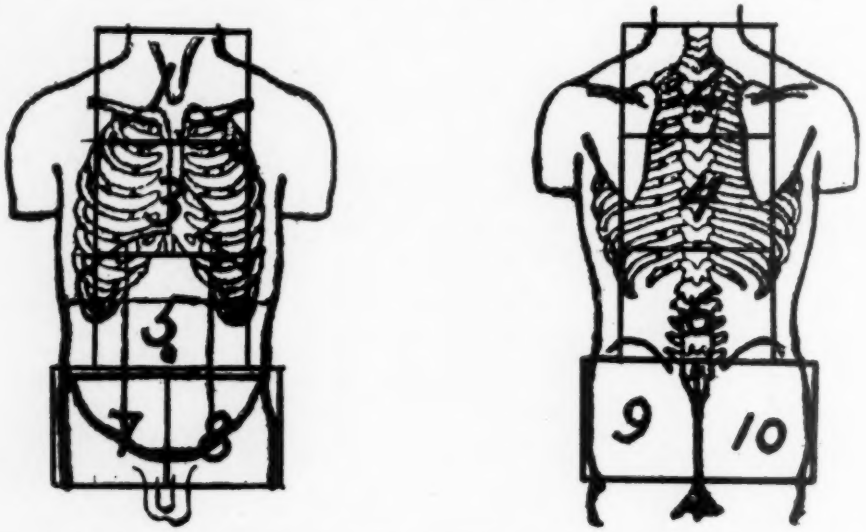

FIG. 7. Fields used in preoperative irradiation. Treatment is delivered consecutively in the order indicated, and the cycle is repeated until 1,600 roentgens, measured in air, has been administered to each field. Fields 1 to 6 are 15 by 20 cm.; fields 7 to 10 are 15 by 15 cm. Field 11 (not drawn in) is chosen large enough to cover the testicular tumor, and treatment to this field is not started until at least 1,000 r has been delivered to each of the other fields. The normal testicle is protected by a lead cup.

If postoperative therapy is the method of choice, the following program is presented as a satisfying procedure. On the strength of clinical evidence of a malignant tumor, the testis should be removed with the least possible trauma, preferably by preliminary ligation and section of the spermatic cord. A roentgen examination of the chest, an intravenous urogram and bone survey, if indicated, should be made preoperatively. As soon as possible after surgery, two or three days if the patient can be brought to the department, a course of deep roentgen therapy should be started over the lymphatic drainage areas. The primary drain-

age areas, situated about the celiac axis, should be completely treated first, followed by successive fields upwards to include finally the left supraclavicular area, and downwards to include the inguinal regions and pelvis. The order of the treatment fields is shown in the diagram in Figure 8. The recommended treatment factors are: 200 kv., 15 ma., 0.5 mm. Cu plus 1 mm. Al, 80 cm. target-skin distance. The half-value layer with these factors is 0.9 mm. Cu. The treatment fields should extend at least 10 cm. to each side of the midline. Each field, anteriorly and posteriorly, should receive at least 1,600 r, measured in air, in divided daily doses. The increase in dosage over our previous conventional treatment is based on our observed difference in radiosensitivity of the various pathologic types, especially the poor response of metastases from the heterologous tumors. In patients with known metastases, the total dosage should be carried to the limit of skin tolerance.

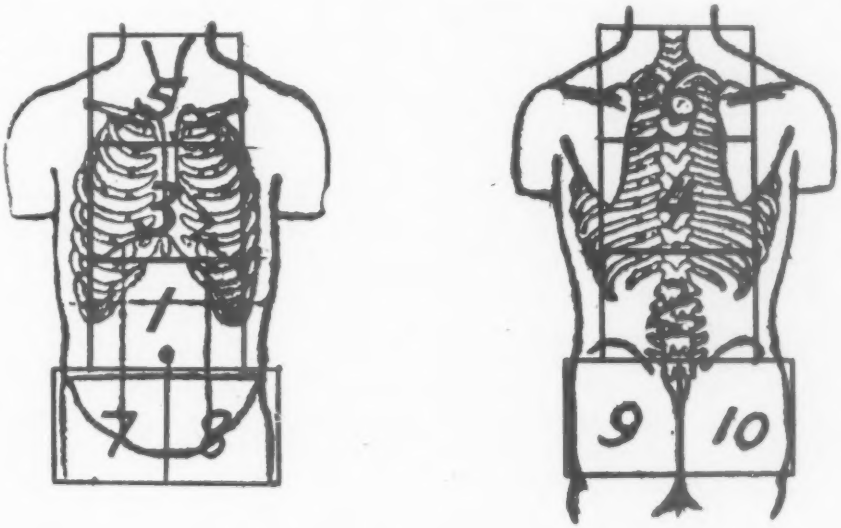

FIG. 8. Fields used in postoperative irradiation. Treatment is completed in each region in the order indicated, before proceeding to the next one. The total dose to each field is 1,600 roentgens, measured in air. Fields 1 to 6 are 15 by 20 cm.; fields 7 to 10 are 15 by 15 cm.

SUMMARY

1. A series of 43 patients with known malignant tumors of the testis is reviewed.

2. The overall five year survival rate is 42 per cent.

3. Histopathologic type, freedom from demonstrable metastases on admission, and carefully planned irradiation are the principal factors affecting the prognosis.

4. The five year survival rate in patients free from demonstrable metastases on admission and receiving "conventional" therapy is 71 per cent. In those with metastases on admission, the corresponding result is 30 per cent.

5. Five patients with heterologous tumors had metastases on admission, and all succumbed to the disease. One patient with a homologous tumor had metastases when first seen and is alive and free from evidence of disease five years after orchiectomy.

6. There are 4 patients (of a total of 24) who had clinically evident metastases at some time during their illness, and who are alive and well five to sixteen years after their last treatment, and in one case there had been a supraclavicular mass.

7. We have been unable to demonstrate any difference in end-results between preoperative and postoperative irradiation.

8. Preoperative or immediate postopera-

tive irradiation is recommended in all patients with a malignant tumor of the testis, regardless of the presense or absence of clinical evidence of metastases.

University Hospital
Philadelphia, Pa.

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Vol. 55, No. 5

INTRAPULMONARY AIR PRESSURE AND ITS RELATION TO PULMONARY CAPILLARY FLOW*

By W. WALTER WASSON, M.D.
DENVER, COLORADO

IN PRESENTING a paper dealing with "Intrapulmonary Air Pressure and Its Relation to Pulmonary Capillary Flow," I realize that I am again opening a subject which has been ably investigated and discussed for the past three-quarters of a century. The ventilation of the lungs and the processes of respiration are, when considered as a single process, such a delicately balanced mechanism that it must command the respect of any surgeon or physician who may attempt to tamper with its function, or evaluate its activities as portrayed by the roentgenogram. The evaluation of a roentgenogram of the chest is an evaluation of the air content of the lungs and the relation of this air content to the anatomical structures and the pulmonary circulation. The proper balance between the ventilation of the lungs, the respiratory processes and the pulmonary circulation is vital to every patient either following an operation or in the sick room.

The literature concerning the pulmonary circulation gives first consideration to the propelling action of the heart. The dynamics of the chest are a substantial aid to the propelling action of the heart. The variations of the intrathoracic pressures have their effect upon the veins of the mediastinum. All the physiologists agree that the negative intrathoracic pressure created upon inspiration is very effective in pulling the blood into the chest, the mediastinum and the heart, while the valves in the veins prevent this blood from being forced away from the chest upon expiration. The action of the heart and the influence of the dynamics of inspiration and expiration are well described in the text books of physiology.

The other subject given a place of importance in the literature is the nature of the flow of blood within the pulmonary capillaries. This has been a matter of debate for many years and has had the attention of very able investigators. For detailed study, the reader is referred to the writings of Coryllos and Birnbaum and of Van Allen and his associates and to the bibliographies of their articles. The question has been whether the pulmonary capillaries were compressed or dilated in such conditions as atelectasis and pneumonia, and what influence this would have upon the blood flow within the capillaries. All the data at hand seem to show that there is a hindrance to the capillary flow in these pathological states. Coryllos and Birnbaum[1] contend that they have proved that there is a compression of the capillaries in atelectasis, and that pneumonia is a similar condition and also has compression of the capillaries[1a,1b] It is also stated that there is an increased capillary flow in emphysema, the opposite state of ventilation to that of atelectasis.[1c] My purpose in making this presentation is to analyze the known anatomical and physiological facts and to call attention to the importance of the intrapulmonary air pressure; that is, the air column within the bronchi and air sacs. For

[1] Coryllos, P. N., and Birnbaum, G. L. Circulation in the compressed, atelectatic and pneumonic lung. *Arch. Surg.*, 1929, *19*, 1346–1424.

[1a] (p. 1421) "Circulatory changes are similar in the compressed atelectatic and consolidated (pneumonic) lung. They do not affect the pulmonary arterial tree but are exclusively limited to the capillaries."

[1b] (p. 1380) Quoting Torek (*Arch. Surg.*, 1927, *16*, 316): "We . . . therefore come to the conclusion that the greatest amount of blood is found in the expanded lung, less in the collapsed lung and least in the compressed lung."

[1c] (p. 1411) "If our conception is right, in these last cases (asthma and emphysema) circulation must remain intact or even be increased in the capillaries."

* Presented at the Forty-third Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 15–18, 1942.

the sake of clarity, all unnecessary details will be omitted.

The important known points concerning the anatomy of the lungs are as follows:

a. There are two systems of capillaries—the capillaries from the pulmonary artery which are located in the walls of the air sacs and which have to do with respiration, and the capillaries of the bronchial artery which come indirectly from the aorta and which are nutrient vessels.

b. The pulmonary capillary walls consist of a single layer of endothelium in the walls of the air sacs (Maximow),[2] and "are found naked to the air spaces" or the air columns. Some anatomists (Miller)[3] insist that there is a single layer of cells lining the air sacs which others call cell platelets. However, it is important to remember that at most there are not more than two layers of cells between the capillary blood stream and the air columns within the air sacs (Fig. 1).

c. It is estimated that the air sac surface of the lungs is 140 square meters (Hufner),[4] or something more than 1,000 square feet. The same estimate is given for the capillaries as they are practically side by side in the air sac walls.

d. On the distal or pleural side of the capillaries opposing the air column, there is a substantial framework of collagenous, reticular, and elastic fibers in a supporting membrane. These fibers extend down to the air sacs from the bronchi along the bronchioles, and also connect with the pleura. It is important to note the difference in the support for the delicate capillaries between the pleura and the elastic fibers on the one hand, and the air column, on the other. Miller[5] states that the elastic fibers may have something to do with the action of the lungs other than merely giving them elasticity (Fig. 2).

e. No nerves, no muscle tissues, and no

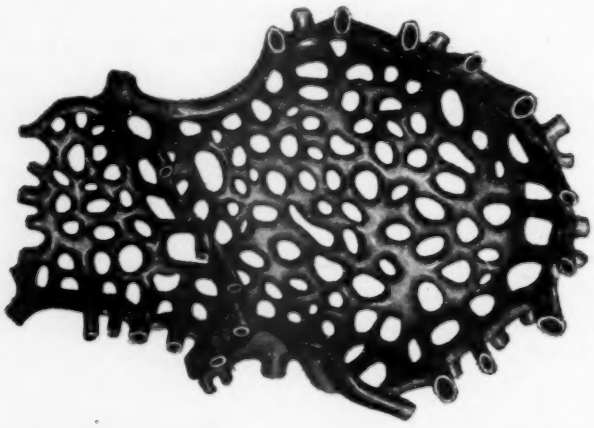


FIG. 1*A*. Network of capillaries in the walls of the sacculi alveolares. (Reproduced by permission from Miller,[3] p. 71.)

[2] Maximow, Alexander A. A Text-book of Histology. W. B. Saunders Co., Philadelphia, 1930. (p. 456) " . . . in the lungs he injected, the capillaries of the future respiratory portion of the lung were always found naked against the 'air spaces'."

[3] Miller, William Snow. The Lung. Charles C Thomas, Springfield, Illinois, 1937. (p. 62) " . . . in the normal lung, the epithelium lining the alveolar walls is made up of thin, flattened, nucleated squames, which are closely applied to the alveolar wall, and that it is a continuous epithelium." (p. 17) "Tracheal and Bronchial Epithelium." "By some authors, for example, F. E. Schulze, the epithelium is described as consisting of a single layer of ciliated columnar cells interspersed with goblet cells."

Coryllos, P. N., and Birnbaum, G. L. Circulation in the compressed, atelectatic and pneumonic lung. *Arch. Surg.*, 1929, *19*, 1346–1424. (p. 1349) "The total surface of the lung should be, according to Hufner (in Starling, Principles of Human Physiology, p. 907) about 140 square meters, this would be equal to 1,000 square feet."

[5] Miller, William Snow. The Lung. Charles C Thomas, Springfield, Illinois, 1937 (p. 144). [Elastic fibers] "serve to tie the pleura proper to the walls of the alveoli and at the same time to assist in respiration. It is also quite probable that the elastic fibers within the areolar layer of the pleura have a similar action to those within the pulmonary walls, since, due to the continuance of the elastic fibers of the blood vessels with these fibers, they must exert an influence on the circulation of the blood and lymph."

lymphatics have been demonstrated in the air sac walls.

f. The air sacs and their capillaries are therefore placed between the pleura, a comparatively strong elastic membrane, and the body of the lungs composed of bronchi, arteries and veins. The body of the lungs is moderately elastic and may stretch on inspiration, but it is also quite compressible when devoid of air and blood, especially in the infant and young child.

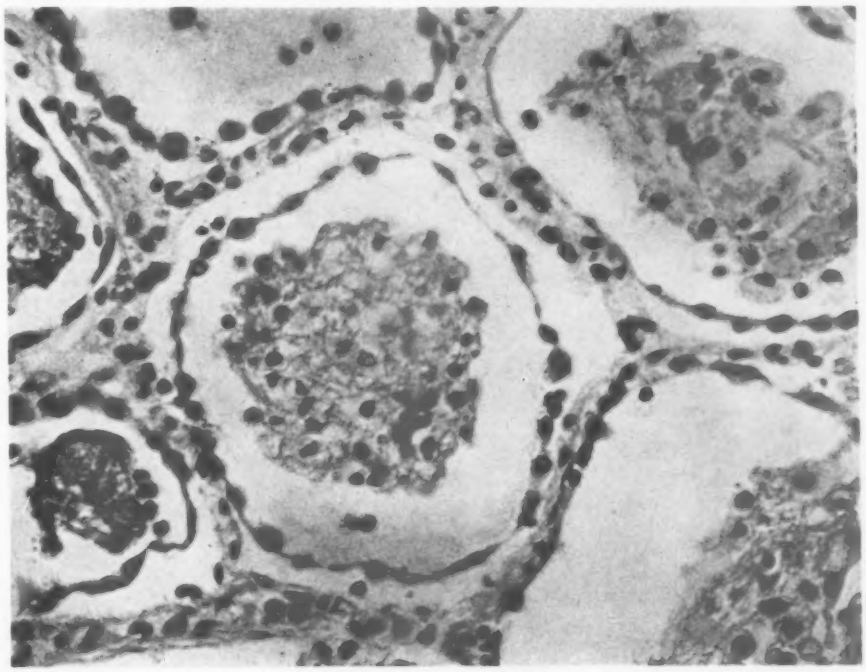


Fig. 1*B*. The epithelium lining the alveolus in the center of the figure has been pushed off as a continuous sheet. Certain of the cells are more swollen than others. The alveolus in the upper right of the figure shows clearly the epithelium before and after an exudate has raised it from the surface of the alveolar wall. (Reproduced by permission from Miller,[5] p. 63.)

The important known facts concerning the physiology and the dynamics of the air sacs are as follows:

a. There is a very close association between the functions of respiration and the pulmonary circulation. Not only does the concentration of the gases affect the exchange of the gases between the blood stream and the air within the air sacs but also the rapidity of the heart action.

b. The blood pressure in the pulmonary artery of the fetus is equal to or slightly greater than the blood pressure in the aorta. The blood is supposed to flow through the ductus arteriosus into the aorta from the pulmonary artery, but as determined by animal experimentation (Pohlman),[6] immediately upon the first inspiration the blood pressure within the right ventricle drops to one-third or one-fourth that in the left ventricle. This phenomenon has not been satisfactorily explained. It is in accord with my own studies (Fig. 3) of the aeration of the lungs after birth.[7] This aera-

[6] Cited by Hamilton, W. F., Woodbury, R. A., and Woods, E. B. The Relation between Systemic and Pulmonary Blood Pressures in the Fetus. *Am. J. Physiol.*, 1937, *119*, 206–212. (p. 209). "The systolic pressure in the right ventricle, however drops during inspiration three or four times as far."

[7] Wasson, W. W. Roentgenographic study of the infant chest as seen at birth. *J. Am. M. Ass.*, 1924, *83*, 1240–1242. Reprint (p. 4). "We called the lung fully expanded when there was air throughout all the parenchyma and no evidence of scattered density suggesting remaining atelectasis. The interval of time for this to take place ranged from five minutes to two weeks, and, in general, compared very closely with the clinical observations described by Pearce and von Reuss."

tion began with the first inspiration but required a period of from a few hours to two weeks to be completed. Neither has a satisfactory explanation been given for the closure of the ductus arteriosus in the human being. In certain animals its closure is due to the adherence of a membrane about the opening.

c. After the initial drop in the blood pressure within the pulmonary artery following the first inspiration, the relation of one to four or five[8a] between the pressure within the pulmonary artery and the aorta is

FIG. 2*A*. Shows the arrangement and ramification of elastic fibers. (Reproduced by permission from Miller,[3] p. 53.)

[8a] Brock, R. C., and Spurrell, W. R. Direct measurement of the pulmonary blood-pressure in man. *Guy's Hosp. Rep.*, 1939, *89*, 262–266 (p. 262). Two patients, inoperable bronchial carcinomata

maintained throughout life except in certain disease conditions.[8b]

d. It is stated by Mallory[8c] that the thickness of the left ventricular wall is 0.3 cm. at birth and that of the right ventricular wall is 0.3–0.5 cm., and in the adult the left wall is 1.5–2 cm. thick and the right one, 0.5–0.7 cm. Boyd[8d] records the adult measurements as: left, 10–15 mm., right, 5 mm. Abt's Pediatrics[8e] is more complete in its information, as it is stated there that at birth the left ventricular wall measures 4–4.5 mm. and the right wall, 3–4 mm.; at one year, the left is twice the thickness of the right, and at puberty it is three times as thick (see Diagram 1, Fig. 4). According to these figures there is then very little increase in the thickness of the right ventricular wall after birth.

Fig. 2*B*. A secondary lobule illustrating how elastic fibers extend to air sacs along the bronchioles and connect with the pleura. (Reproduced by permission from Miller,[3] p. 192.)

e. The blood pressure within the pulmonary capillaries is estimated to be 7 to 9 mm. of mercury, and that of the pulmonary

cases, were operated upon at different times, one a thoracotomy and one a pneumonectomy. Estimations of mean pressures were made by insertion of a needle into pulmonary circulation. In the male, mean pressure was 36 mm. Hg; at the same time, the systemic blood pressure was 115 mm. Hg systolic, and 75 mm. diastolic. In the female, the pulmonary arterial pressure at expiration was 29.4 cm., and at inspiration 28.8 cm. "in terms of Hg mean pulmonary arterial pressure, 22 mm."

[8b] Johnson, V., Hamilton, W. F., Katz, L. N., and Weinstein, W. Studies on the dynamics of the pulmonary circulation. *Am. J. Physiol.*, 1937, *120*, 624–634.

The authors stress the need for experiments on animals under normal conditions of breathing.

[8c] Mallory, F. B. Pathological Technique. W. B. Saunders Co., Philadelphia, 1938.

[8d] Boyd, William. A Text-Book of Pathology. Third edition. Lea & Febiger, Philadelphia, 1938.

[8e] Abt's. Pediatrics. W. B. Saunders Co., Philadelphia, 1924, Vol. IV, Chapter 69, p. 239.

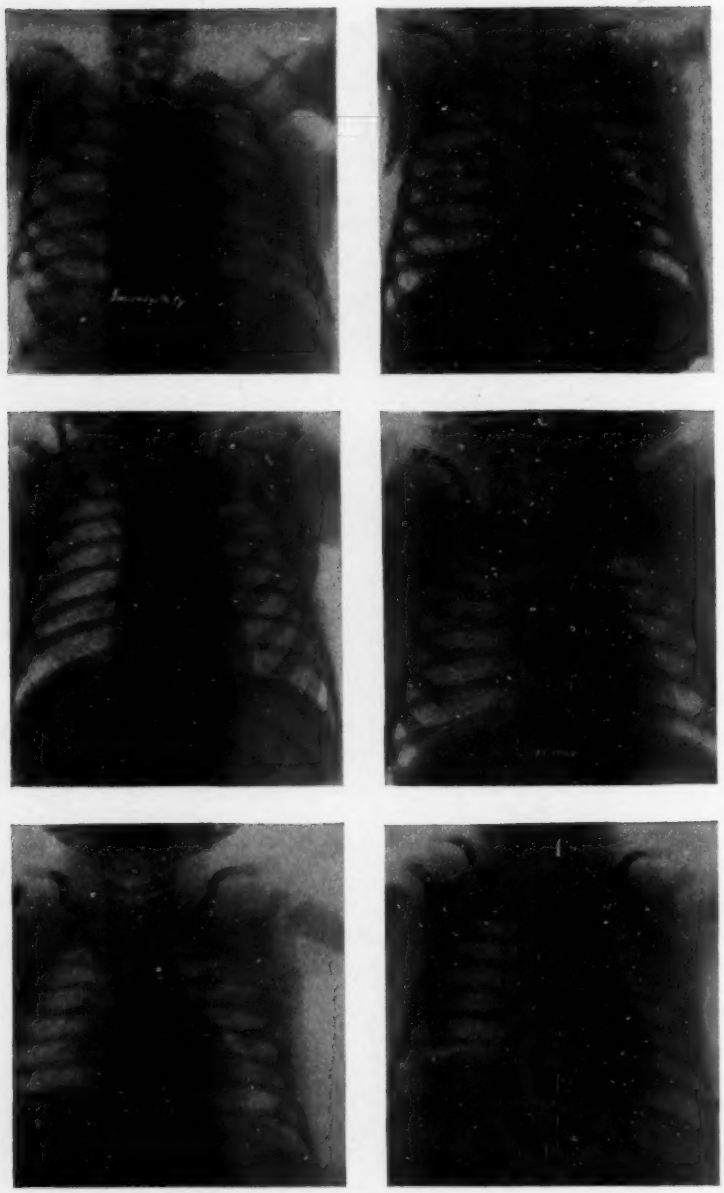


FIG. 3. Roentgenograms of an infant from birth until leaving hospital. Note gradual expansion of lungs. Roentgenograms were made immediately after birth; at five, ten and fifteen minute intervals thereafter; the second day of life, and upon leaving the hospital showing the gradual aeration of the human lung. (Reproduced by permission from Wasson, W. W. Radiography of the infant chest, with special reference to the "progression of the chest and the determination of the normal." *Radiology*, 1925, *5*, 365–398.)

veins at the heart as 11 to 19 mm. of mercury*[9a] (Diagram 2, Fig. 5).

f. The intrapulmonary air pressure is stated to be one atmosphere or equal to that

* These figures are presumed on a basis of animal experimentation as they are not known for man. In an earlier edition of the reference in which they appear, the pulmonary capillary pressure was estimated at 3 to 5 mm. of mercury,[9b] and the pulmonary venous pressure as 3.6 mm. of mercury.

[9a] Macleod, J. J. R. Macleod's Physiology in Modern Medicine. Edited by Philip Bard. Ninth edition. C. V. Mosby Co., St. Louis, 1941. "PULMONARY VENOUS PRESSURE. . . . The venous pressure averages 3 to 12 mm. Hg relative to the atmosphere or

upon the chest wall.[10] There are, however, certain variations with decrease or increase of this pressure due to inspiration and expiration.

g. The average amount of air exchange on inspiration or expiration at quiet breathing is 500 cc., but this amount may be increased by 1,500 cc. more on either forced inspiration or forced expiration. About 1,500 cc. of air remains in the lungs after forced expiration.[11]

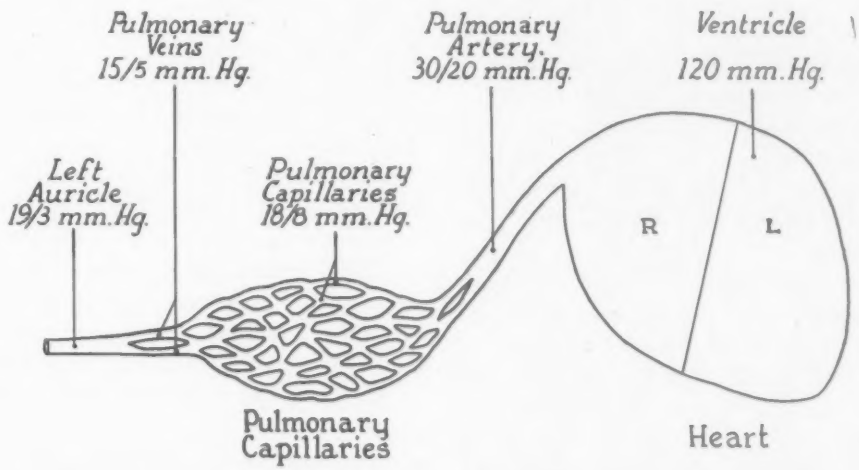
h. The elastic fibers over the air sacs and in the pleura hold back the atmospheric pressure within the air sacs to the extent of creating a negative intrapleural pressure of −5 mm. of mercury, which may be increased to −10 mm. of mercury on inspira-

THICKNESS OF VENTRICULAR WALLS AT VARIOUS AGE PERIODS

Age	Left	Right
Birth	*4-4.5mm** *0.3cm.***	*3-4mm.** *0.3-0.5cm.***
1 year	*2X right**	
Puberty	*3X right**	
Adult	*1.5-2cm*** *10-15mm****	*0.5-0.7cm*** *5mm****

* Abt's Pediatrics, 1924
** Pathological Technique, F.B. Mallory, 1938
*** A Text-book of Pathology, Wm. Boyd, 1938

FIG. 4. Diagram 1. A chart showing the relative thickness of the right and left ventricular walls at various ages.



PRESSURE GRADIENT OF LESSER CIRCULATION

Data from Macleod's Physiology in Modern Medicine, 1941

FIG. 5. Diagram 2. Diagrammatic representation of the pressure gradient in the lesser circulation.

11 to 19 mm. relative to the intrathoracic pressure." "PRESSURES IN THE PULMONARY CAPILLARIES.—The pressures in the capillaries of the lung are not known even for animals. One must assume that they are below the normal diastolic arterial pressure of 11 mm. and above the normal venous pressure of about 7 mm. When the diastolic pressure in the pulmonary artery is itself 7 mm., the capillary pressure must be still lower. The pulmonary capillary pressure may be provisionally considered as about 9 mm. Hg."

[9b] *Idem.* Eighth edition. C. V. Mosby Co., St. Louis, 1938. "THE PULMONARY VENOUS PRESSURE.—Wiggers (Carl J.: Physiological Reviews, April, 1921) considers the normal filling pressure of the left auricle relative to the subatmospheric pressure to be 3.6 mm. Hg." "THE PRESSURE IN THE PULMONARY CAPILLARIES. . . . The pressures within the lung capillaries are not known. Presumably they must be below the normal diastolic pressure of 5 mm. They must exceed venous pressures. A provisional estimate of 3 to 5 mm. may be made."

[10] Wright, Samson. Applied Physiology. Seventh edition. Oxford University Press, New York, 1940 (p. 503). "INTRAPLEURAL PRESSURE: . . . The pressure in the pleural cavity is *subatmospheric*, and is −5 mm. Hg (i.e. 5 mm. less than atmospheric) during expiration and −10 mm. Hg during inspiration. The pressure in the lungs is about 1 atmosphere, as they are in free communication with the outside air. The full intrapulmonary pressure is not transmitted to the pleural cavity, however, owing to the *elastic recoil of the lungs*."

[11] Zoethout, W. D., and Tuttle, W. W. A Textbook of Physiology. Seventh edition. C. V. Mosby Co., St. Louis, 1940 (p. 291). "The amount of air we take in by quiet inspiration, called

tion.[10] This negative pressure within the pleural space must in turn create a slightly positive pressure within the air sacs and upon the walls of the capillaries. Many anatomists stress the possible importance of the elastic fibers of the bronchi, the air sacs, and the pleura in expiration. Some physiologists (Maximow)[12] state that in quiet respiration the chest wall descends passively, and that it is the elastic fibers which squeeze the lungs and force out the air.

COMMENT

In making a general survey of the anatomy of the air sacs, their physiology and the phenomena which take place within them, one cannot but be impressed with their delicate structure and the finely balanced mechanism which enables them to function. To unravel the various functions of the lungs and the phenomena concerned with respiration has required the life-long labors of many scientists. William Snow Miller spent thirty-two years before he finally obtained one particularly desired microscopical section of the lung. The thin-walled air sacs and capillaries would be more frequently damaged and ruptured if there were not 1,000 square feet of air sac surface[4] to accommodate the inrush of air through the trachea. While the changes of pressure are considerable in the trachea, the 500 cc. of air necessary for quiet breathing[11] is rapidly diffused throughout the extensive air sac spaces and creates no strain upon any particular portion of the lung. This absorption of the stress and strain is also true in forced inspiration and expiration. Twenty times the capacity needed for ordinary respiration is a considerable latitude for overloading.

Viewing the capacity of the lungs from known figures of air capacity gives some insight into the possibilities of the pulmonary circulation. The capillaries have an area of 140 square meters similar to that of the air sacs; 140 square meters or more than 1,000 square feet, and the blood supplying this large pool comes from one single artery with a diameter comparable to that of the trachea. It must be that the pulmonary capillaries can handle the supply of blood from the heart with the same ease that the air sacs handle the exchange of air in respiration.

Turning now to an analysis of the dynamics more directly concerning the air sacs and the pulmonary capillary flow, it must be remembered that the volume of blood will be greatest in the tube with the greatest diameter (law of continuity of fluids).[13] In other words, the smaller the capillaries, the more hindrance there is to capillary flow. If in atelectasis and pneumonia there is a compression of the capillaries then there will be a definite interference with the capillary flow. This is the position taken particularly by Coryllos and Birnbaum.[1] On the other hand, I have found very little in the literature concerning the importance of the air column in the bronchi and air sacs as an aid in supporting the capillary walls and as an aid to the circulation within the pulmonary capillaries under normal conditions. One writer (Pohlman)[14] speaks of the air backing up the

tidal air, is usually found to be about 500 cc. (30 cubic inches). In addition to this we can, by forced inspiration, inhale from 1,500 to 2,000 cc. more; this is called the *complemental air*. By forced expiration we can expel about 1,500 cc. more than we do by quiet expiration; this quantity is known as the *supplemental air*. Even after the most forcible expiration there remains a quantity of *residual air* estimated at about 1,500 cc."

[12] Maximow, Alexander A. A Text-Book of Histology. W. B. Saunders Co., Philadelphia, 1930 (p. 459). "An increase in the size of the thorax, such as occurs with every inspiration, increases the negative pressure in the pleural cavity; consequently the lung sucks in more air and becomes larger, and its elastic and reticular fibers are put under still greater tension. This is purely a passive activity on the part of the lung. In expiration, as the thoracic cavity becomes smaller, the negative pressure in the pleural cavity is lessened. This decreases the tension on the elastic and reticular fibers and they pull the lung into a more contracted state, thus forcing some of the air out. It is quite probable that the smooth muscles of the alveolar ducts and the bronchioles also help force the air out of the lung by their contraction. This muscular activity is thought to be under the control of the autonomic nervous system."

[13] Kimball, A. L. A College Text-Book of Physics. Third edition. Henry Holt & Co., New York, 1926, p. 140.

[14] Hamilton, Woodbury and Woods[8] (p. 209). "After the lung is expanded the heart works against a pressure that is less that atmospheric (somewhere between atmospheric pressure and intrathoracic) and against the elastic resistance of the capillary walls backed up by alveolar air rather than by the relatively solid pulmonary tissue of the collapsed lung."

capillaries. With the capillaries bare in the walls of the air sacs, the support given by the air column must be very necessary to offset the action of the elastic fibers of the air sacs and the pleura. On inspiration, the negative pressure within the pleural space increases from −5 mm. of mercury to −10 mm. of mercury,[10] thereby pulling outward by suction the visceral pleura, and in turn the elastic fibers of the air sac walls. This creates a lower pressure within the air sacs, and air rushes in; but with this same inrush of air there must be an inflow of blood into the pulmonary capillaries from the pulmonary artery. When the chest wall descends and the negative pressure within the pleural space returns to −5 mm. of mercury the elastic fibers contract and squeeze out the air creating for the moment a positive air pressure in the air sacs and bronchi. This action must also certainly squeeze the capillaries between the elastic fiber framework on the one side and the air column on the other. The same effect would be obtained if the force came from the pressure of the chest wall. Then the result is a pressure exerted over 140 square meters of capillary surface and the flow of blood in the capillaries with 7 mm. of mercury pressure is into the veins with a pressure of 11 to 19 mm. of mercury, rather than into the pulmonary artery with a pressure of from 18 to 20 mm. of mercury. A repetition of this action at each inspiration and expiration creates a pumping action upon a large volume of blood (Diagram 3, Fig. 6), and must be quite effective. On inspiration, there is a negative intrathoracic pressure exerted upon the large veins of the lungs which also aids the capillary flow. On expiration, there is a squeezing of these thin-walled veins which may tend to force the blood either into the heart or back into the capillaries. Without the air columns in the bronchi and air sacs there is very little support to the capillary walls and only the compressible lung tissue against which the pleura and elastic fibers may contract. If this air pressure in the bronchi and air sacs is important to the pumping of the blood

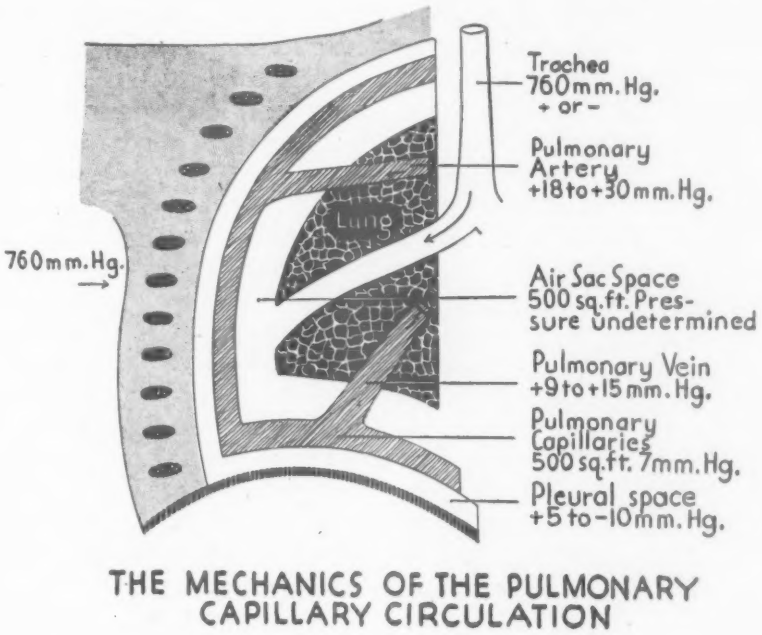


Fig. 6. Diagram 3. Sketch illustrating intrapulmonary air pressures, the pulmonary artery, capillary and venous pressures, and the pumping action of inspiration and expiration.

through the capillaries as an aid to the heart action, then many disease conditions such as passive congestion from cardiac failure would be aided by attention to this function of inspiration and expiration. In other words, inspiration and expiration may not only pump the air in and out of the lungs but also pump the blood through the pulmonary capillaries. In atelectasis and pneumonia, there is not only the interference to the capillary flow by compression of the capillaries but also the loss of this auxiliary to the propelling force of the heart action.

After the first inspiration, the blood pressure in the pulmonary artery of the infant drops to one-third or one-fifth that of the aorta. This can be explained in part by the dilatation of the pulmonary capillaries when the air sacs expand and there is an inrush of a large volume of blood. With the disappearance of the state of atelectasis, the capillaries then have a larger diameter and permit a larger volume of blood to pass and thereby require a lower pressure within the pulmonary artery. However, it does not seem quite reasonable that this state of complete aeration of the lungs can alone explain the phenomenon of the lower pressure within the pulmonary artery and the circulation within the pulmonary capillaries. Heger and Spehl[15] have stated that on inspiration the lungs contain one-twelfth of the volume of blood in the body and on expiration, one-eighteenth of the volume of blood in the body. Coryllos and Birnbaum[16] quote E. K. Dunham's theory that more blood is brought to the capillaries upon inspiration. Torek[17] is quoted by the same authors (Coryllos and Birnbaum) as follows: "In the normal thorax, the negative pressure on the outside of the lung constantly exists; nature established it so that a maximum amount of blood may be sent to the lungs for oxygenation, and with each respiration the suction on the outer surface is increased with a consequent increase in the amount of blood entering the lungs, whereas the expiratory effort drives it out again." Sauerbruch[18] recognized the fact that there is increased blood flow in the lungs during inspiration, but he attributed the increased flow to being mostly due to increase in the diameter of the capillaries. Coryllos and Birnbaum[19] concluded that "Circulation and ventilation of the lung are parallel functions; when ventilation is impaired circulation is decreased, and conversely . . . ," and "In the compressed, atelectatic (apneumatic) and consolidated lung, the circulation is progressively impaired. This impairment is due to, and regulated by, the degree of collapse of the alveoli, and not to capillary thrombosis or capillary compression by alveolar exudate as heretofore believed." These statements substantiate the theory that the act of respiration changes the volume of blood within the lungs. Further, the pumping action of the pleura and the elastic fibers of the air sacs in inspiration and expiration together with the changes in pressure of the air columns then aid the heart in maintain-

[15] Coryllos and Birnbaum[1] (p. 1372). " . . . Heger and Spehl (Arch. de biol., 1881), who found that at the height of inspiration the lungs contain one-twelfth of the total volume of blood, whereas at the end of expiration they contain only one-eighteenth of the total volume."

[16] Coryllos and Birnbaum[1] (p. 1377). " . . . Under these conditions (inspiratory capacity increase) more blood will be brought to the capillaries, because of increased blood flow to the right side of the heart . . . ."

[17] Coryllos and Birnbaum[1] (p. 1381).

[18] Quoted by Coryllos and Birnbaum[1] (p. 1367). "Sauerbruch claimed the blood flow through the lung was dependent on four fundamental factors: (1) the strength of the right side of the heart, (2) the difference between the pulmonary artery and pulmonary vein pressures, (3) the intrapulmonary pressure and (4) the changes in the diameter of the capillaries following the changes in the volume of the lung. Assuming that the strength of the right side of the heart is constant, with each inspiratory phase there will be an increase in the negative pressure and suction on the thin-walled pulmonary veins and accordingly an increase of the difference in pressures between the pulmonary arteries and veins, as well as a decrease in pressure of the intrapulmonary air; consequently, there will be an expansion of the lung vessels with an increase in their diameter and capacity and an increased blood flow through the lungs. Furthermore, increased negative intrapleural pressure and the suction exerted on the big intrathoracic vessels (on the thin-walled veins much more than on the arteries) will have as a direct result an increase in the blood flow from the peripheral veins to the right side of the heart, so that during inspiration the heart will receive more blood in diastole and send more blood in systole than during expiration. Under other conditions, as, for example, on expiration, less blood will come to the right side of the heart and less will leave the left side. Sauerbruch gave the mechanism described and concluded: 'The result of these continued causes on inspiration is an increased blood flow in the lungs'."

[19] Coryllos and Birnbaum[1] (p. 1422).

ing this low pressure. As a result of this low pulmonary pressure the pulmonary artery does not rise in the mediastinum as does the aorta. The arch of the aorta in the infant passes directly posteriorly in the mediastinum (Fig. 7), but in a few weeks it grows rapidly to assume a higher position while the pulmonary artery remains below and to the left. This change in position of the aorta and its relation to the pulmonary artery may create a tension upon the ductus arteriosus and effect the closure of the ductus arteriosus.

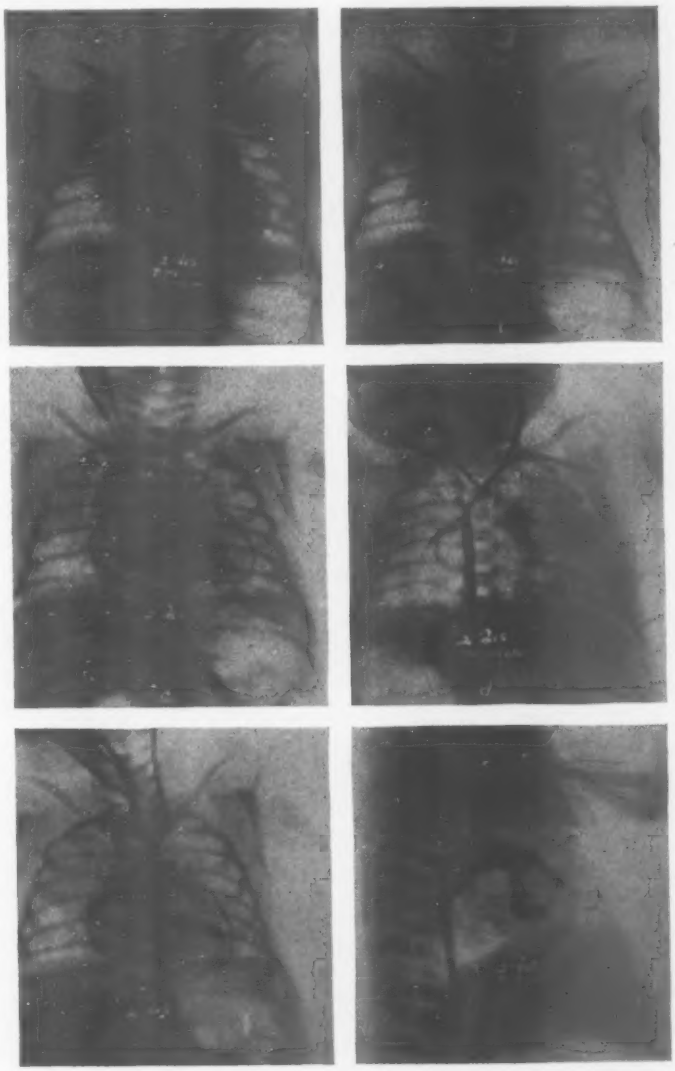


FIG. 7. Roentgenograms of two day old infant after death with mediastinal structures outlined by opaque material and showing the pulmonary artery lying to the left and the aorta passing directly backward from the heart. (Reproduced by permission from Wasson, W. W. Radiography of the infant chest, with special reference to the "progression of the chest and the determination of the normal." *Radiology*, 1925, *5*, 365–398.)

Of course, after such a discussion it would be very interesting to know what would happen if there were a closure of the ductus arteriosus or the foramen ovale before birth and before there was any aeration and ex-

pansion of the lungs. Fortunately, there are cases on record with an accurate and detailed report of the consequences of such early closure. The findings are in accord with what might be expected if all the blood from the right side of the heart was forced to go through the pulmonary artery while the lungs were in a state of atelectasis.

left ventricle together with the blood pressure within the aorta at birth are known, then an equation may be formulated as follows: the thickness of the right ventricular wall is to the thickness of the left ventricular wall as the pressure in the pulmonary artery is to the pressure in the aorta (Diagram 4, Fig. 8).

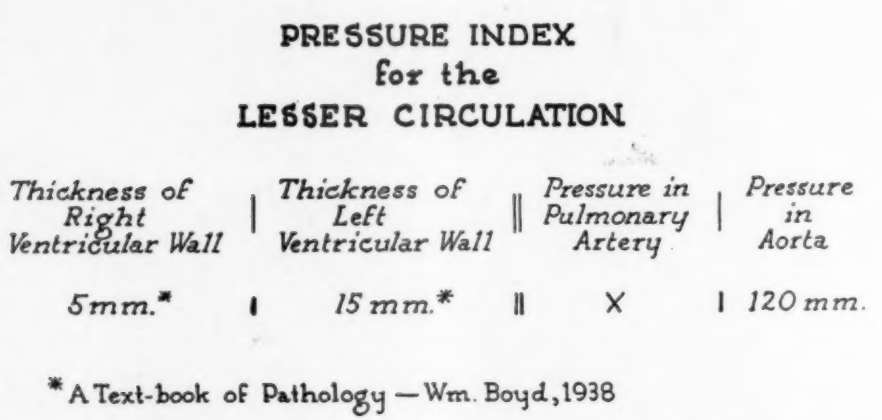


FIG. 8. Diagram 4. Equation for determining the approximate blood pressure within the pulmonary artery.

Benner[20] reported necropsies on a stillborn and an eleven hour old infant in which the hearts of both showed evidence of premature closure of the foramen ovale, and there was a widely patent ductus arteriosus in the stillborn fetus. The pathological findings in both cases were: swelling of the extremities, edema of the skin, atelectasis of the lungs, and congestion of the liver which in the fetus was severe. The muscles of the right auricle were hypertrophied in both cases, and in the infant that of the right ventricle also. It is possible to theorize that if the thickness of the wall of the right ventricle bears a definite relation to the pressure within the pulmonary artery, and the thickness of this wall and that of the

Such an equation should offer some information as to the probable blood pressure within the pulmonary artery at the time

[20] Benner, Miriam C. Premature closure of the foramen ovale. *Am. Heart J.*, 1939, *17*, 437–443. Reprint.

This is a report of two cases with a brief but inclusive review of the literature. The author mentions Lehman's classification (*Am. J. Dis. Child.*, 1927, *33*, 585) of congenital cardiac anomalies: "(1) Infants with marked edema at birth, (2) infants appearing normal at birth but dying with cyanosis within a few days, and (3) atypical cases modified by other major cardiac anomalies." Benner's patients fitted into classes 1 and 2. Marked edema was present in both cases, and the lungs of both were atelectatic. In one, microscopically, there was hypertrophy of the muscle of the right auricle and in the other, the hypertrophy was of the muscle of both right auricle and right ventricle. In the first case, the necropsy report recorded that the "condition was typical of a severe passive congestion," and in the second there was found marked congestion, edema and atelectasis (p. 6). "In case the fetal pulmonary circuit and ductus arteriosus are both inadequate to carry an increased load, the result will be the same as for any obstruction to free circulation, namely, the development of back pressure. This back pressure may cause enlargement of the right auricle . . . the right ventricle . . . and will eventually hinder the entire circulatory flow from the body and the placenta, bringing about stasis and edema of the whole body and placenta, as well as hydramnios. However, in those cases in which the right side of the heart has enlarged disproportionately, the event of birth and shutting off of the passage of blood through the ductus arteriosus will cause a larger volume of blood to go through the pulmonary circuit than can be pumped by the left side of the heart to the aorta. This will cause stasis in the lungs, with pulmonary edema and inadequate oxygenation, as well as failure of the left side of the heart" (p. 7). "The foramen ovale is normally widely patent in fetal life, usually closes within twelve weeks after birth, but may show a probe patency throughout the first year."

of death, and at least the later weeks of life. This is in a measure substantiated by the work of Bruns[21] who found hypertrophy of the right side of the heart following experimental pneumothorax maintained for four months, and "there is no doubt that chronic lesions of the lungs accompanied by atelectatic alterations are followed by hypertrophy of the right side of the heart (Zuntz, Gerhard and Carlstrohm)."[21]

SUMMARY

This paper has endeavored to present certain points as follows:

1. The importance to the surgeon, the physician and the roentgenologist of having an intimate knowledge of the dynamics of the pulmonary circulation.

2. A very brief summary of the literature upon the subject.

3. Important known facts concerning the anatomy and the physiology of the air sacs and the circulation within the pulmonary capillaries.

4. An attempted analysis of the anatomy, physiology, and the dynamics of the air sacs and the pulmonary capillary flow.

304 Republic Building
Denver, Colorado

[21] Coryllos and Birnbaum[1] (p. 1373).

EMPHYSEMATOUS GASTRITIS

By H. STEPHEN WEENS, M.D.

From the Department of Roentgenology, Grady Hospital and Emory University School of Medicine

ATLANTA, GEORGIA

INTRODUCTION

EMPHYSEMATOUS gastritis is an inflammatory process of the stomach caused by a gas-forming organism. It may therefore be classified as a form of phlegmonous gastritis which represents a suppurative cellulitis of the stomach.

Emphysematous gastritis was first recognized in 1889 by Fraenkel[1] in a thirty-five year old man who died after repeated attacks of severe epigastric pain associated with bloody vomitus and diarrhea. The stomach was found on autopsy to have a swollen reddened mucous membrane under which small gas-filled blebs were noted. These vesicles were localized histopathologically between the muscularis mucosae and the submucosa, where round cell infiltration and masses of bacteria were also encountered. Fraenkel attributed the gas formation and inflammatory changes to a rod-like organism whose cultural characteristics were not established at that time.

Morton and Stabins[11] described similar autopsy findings in a seventy-two year old man. This patient was operated on for a ruptured peptic ulcer of the proximal duodenum. After slow recovery which was characterized by repeated vomiting of coffee-ground material, the patient suddenly became worse and died in a shock-like condition. On necropsy the gastric mucosa and submucosa were found to be studded with numerous small gas bubbles. The histopathologic examination revealed extensive inflammatory changes of the gastric wall and the presence of numerous bacteria which, by bacteriologic studies, were identified as *B. welchii*. The authors attributed the severe toxemia of their patient to infection with this organism.

In the following a case of emphysematous gastritis subsequent to ingestion of concentrated hydrochloric acid is recorded. This case is reported, not only because of its rarity, but also to illustrate that the diagnosis of this condition may be established during life by roentgenologic examination.

CASE REPORT*

J. M. (A-101738), a white male, aged thirty-seven, was admitted to Grady Hospital on July 9, 1944, one hour after ingestion of 3 to 4 ounces of muriatic acid (concentrated hydrochloric acid) in an attempt at suicide. The patient's history revealed periods of mental depression with increased alcoholic intake. At the time of the incident the patient was said to have been in a state of mild intoxication.

On physical examination no signs of peripheral collapse were noted. The blood pressure was 178/100 and the heart and lungs were normal. The mucous membrane of mouth and pharynx showed extensive burns. The abdomen was distended and tender throughout on palpation.

After emergency treatment with egg white, amphojel and sodium bicarbonate, gastric lavage was done and 600 cc. of bloody material containing flecks of tissue were aspirated. Plasma, normal saline, and 1/6th molar sodium lactate solution were administered parenterally.

The roentgenologic examination on admission revealed a large amount of air and fluid in the fundus of the stomach, but there was no evidence of free air in the peritoneal cavity.

On the following day his condition had improved considerably. The abdomen was soft and not distended, but he still continued to complain of abdominal pain. Repeated gastric lavage yielded bloody flakes of mucous membrane. He was now able to drink small amounts of fluid.

On the third day, shortly after taking a small amount of soup and milk, he suddenly complained of severe pain in the epigastrium and the left side of the abdomen. Since gastric perforation was suspected roentgenograms of the abdomen in the upright position were obtained

* I am indebted to Dr. J. Frank Harris for clinical data.

which failed to disclose free air under the diaphragms. There appeared, however, a large group of small gas bubbles throughout the left side of the abdomen which formed a rather characteristic silhouette of the stomach (Fig. 1). The gas vesicles were collected chiefly along the curvatures and the fundus of the stomach where they formed a continuous mottled band of decreased density. For this reason, it was believed that the gas formation had taken place mainly in the wall of the stomach itself. This impression was confirmed by immediate roentgenoscopic and roentgenographic examination of the patient after aspiration of the gastric contents.

The material which was removed from the stomach had a grayish-brown color, a fecal odor, and contained a small number of gas bubbles. Cultures of this material revealed *B. proteus*.

The subsequent course was characterized by continued epigastric pain and vomiting. He received frequent blood transfusions and clyses and was gradually able to take more fluid by mouth though there was increasing difficulty in swallowing. In order to combat infection sulfadiazine was given in daily doses of 3 to 7 grams from the day of admission for a period of three weeks without significant effect on the clinical course. The temperature during this time ranged from 99.0 to 102.4° F. The urine was grossly bloody on admission, but cleared by the eighth hospital day. The leukocyte count which, on admission, was 29,000 with 98 per cent polymorphonuclears, gradually returned to a normal value.

In the hospital the patient was examined frequently by the roentgen department. The gas formation in the stomach wall was most pronounced for two weeks (Fig. 2 and 3). On two examinations (July 15 and 19, 1944) small amounts of bismuth, administered orally, clearly outlined the inner surface of the stomach and demonstrated the extensive gas formation in the gastric wall. The blebs varied in size up to 3 cm. in diameter and showed occasional fluid levels.

During the third hospital week the patient's condition again became worse. He repeatedly vomited small amounts of bloody material and complained of epigastric pain continually. On the twenty-first hospital day the temperature suddenly spiked to 103.6° F. A blood culture taken at this time grew *A. aerogenes*. The patient then received penicillin in daily doses of 50,000 to 200,000 units for one week. The temperature gradually returned to normal, but it was not felt that penicillin was responsible.

FIG. 1. Abdomen in upright position. Numerous gas bubbles, chiefly localized in gastric wall. Ulcer of lesser curvature?

The gas formation in the stomach wall gradually decreased and was last observed on August 5, 1944.

A gastrointestinal examination with barium sulfate (August 14, 1944) revealed that the esophagus had a rigid pipe-like appearance with numerous smooth areas of constriction. The stomach was filled with slight delay and was found to be markedly reduced in size. The mid portion of the stomach showed a fusiform constriction which allowed the passage of only a small amount of contrast medium (Fig. 4).

On August 29, 1944, a gastrostomy was performed with insertion of a tube into the lower portion of the stomach. The entire wall of the stomach was found to be markedly thickened and numerous adhesions were noted between the lesser curvature and adjacent organs. After the operation the patient's condition improved considerably and he was temporarily discharged from the hospital. He was able to take increasing amounts of food by gastrostomy tube and gained weight. Since the mid portion of the stomach was markedly constricted a second gastrostomy was performed on October 15, 1944, with insertion of a tube into the upper

FIG. 2. Seventh hospital day. Contrast medium outlines mucosa. Extensive gas formation in gastric wall.

FIG. 3. Eleventh hospital day. Gas formation less pronounced. Stomach slightly smaller.

portion of the stomach. It was contemplated to utilize this gastrostomy for dilatation of the esophagus. At this second operation numerous dense adhesions between the stomach and adjacent organs including the diaphragms were encountered and freed with difficulty. The immediate postoperative course was uneventful but after an interval of about one week there was a purulent drainage from the upper gastrostomy tube. From this time on a gradual retrogressive course was noted. Spiking temperature, chills, pain in both shoulders, and left pleural effusion were considered to be the result of intraperitoneal abscess formation. It was believed that there had been a rupture of an abscess into the stomach or the gastrostomy canal. The patient died on January 12, 1945.

FIG. 4. Five weeks after admission. No residual gas formation. Stomach markedly contracted with fusiform stricture in mid portion.

Essential autopsy findings were as follows: The esophagus showed extensive scarring of the mucous membrane throughout its mid portion but there was no complete obstruction. The stomach was markedly contracted, measuring 10 cm. in length and 2.5 cm. in its greatest diameter. The mid portion of the stomach was completely obliterated and narrowed to a cord-like structure. The gastric wall was very thick and fibrotic. A large abscess was found between

the left diaphragm, the spleen and fundus of the stomach in communication with the upper gastrostomy wound of the stomach. Small thrombi were noted in the proximal segments of the splenic and gastro-epiploic veins. Several large abscesses, measuring from 1 to 9 cm. in diameter, occupied the right lobe of the liver. *B. coli* was cultured from these abscesses.

Comment. A man, aged thirty-seven, after ingestion of concentrated hydrochloric acid, developed an emphysematous inflammation of the stomach. Extensive gas formation in the gastric wall was demonstrated roentgenologically for a period of approximately four weeks. The infection of the stomach was followed by marked scar formation which resulted in complete obstruction of the mid portion of the stomach and necessitated two gastrostomies. It is conceivable that *B. proteus* which was cultured from stomach contents and *A. aerogenes* which was grown from a blood culture may have participated in the gastric infection and gas formation. After temporary recovery the patient developed (three months after his first hospital admission and one week after the second gastrostomy) a subphrenic abscess which was apparently followed by thrombosis of the splenic and gastro-epiploic veins and multiple liver abscesses. The clinical course suggests that the latter events were most likely independent postoperative complications and not the flare-up of a quiescent infection.

DISCUSSION

As stated in the introduction, emphysematous gastritis may be classified as a form of phlegmonous gastritis, a process usually caused by an infection with streptococci. In some instances, however, the presence of *B. coli*, as a causative organism, has been recorded.[20] It is noteworthy that in Sundberg's[20] collected series of 250 cases, a history of alcoholism, which we also observed in our case, was encountered in approximately one-fourth of the patients. This author believed that epithelial damage in alcoholic gastritis may facilitate bacterial invasion of the submucosal layers. On several occasions trauma, such as dilatation of an esophageal stricture, was believed to be an important factor in the development of phlegmonous gastritis. One case of this series occurred after oxalic acid poisoning. In another case phlegmonous gastritis developed after ingestion of potassium iodide and calomel in an attempt at suicide.

The question arises as to which organism may have caused the inflammatory changes and gas formation in the stomach of the case described above. In this connection it should be remembered that in recent years an increasing number of emphysematous infections of the viscera, due to gas-forming organisms, have been recognized; among them, inflammations of the urinary bladder, gallbladder and uterus. Mills[10] observed 7 cases of emphysematous cystitis in the autopsy material of the Mayo Clinic, and Ravich and Katzen[15] described a case of emphysematous cystitis which was diagnosed during life and led to recovery. Ravich and Katzen confirmed the opinion of Schoenberg[17] and Nowicki,[12] who attributed the gas formation in this condition to coliform organisms. In 2 case reports *B. welchii* was isolated in emphysematous cystitis.[3,9]

Stevenson[19] reported 3 cases of emphysematous cholecystitis, in which the gas formation in the wall and bed of the gallbladder was believed to be caused by *B. welchii*. He was, however, unable to offer bacteriologic proof for this conception. All 3 patients recovered.

Emphysematous infections of the uterus due to *B. welchii* have been repeatedly described.[14,16] Some of the patients with emphysematous cystitis and cholecystitis were diabetics in whom, according to Gillies,[5] gas infections are frequently due to *B. coli* and not to the group of gram-positive, spore-bearing organisms such as *B. welchii*.

In the absence of direct bacteriologic studies of the stomach, at the time when infection and gas formation were present, it is impossible to arrive at definite conclusions as to the causative organisms in the described case. *B. proteus*, which was

cultured from the aspirated stomach contents, is known to be a gas-forming organism. The positive blood culture for *A. aerogenes* may be of clinical significance. Hill, Seidman, Stadnichenko and Ellis,[6] in a most careful bacteriologic study of 200 cases of genito-urinary infections, were not only impressed by the high incidence of *A. aerogenes* but also stressed the fact that 75

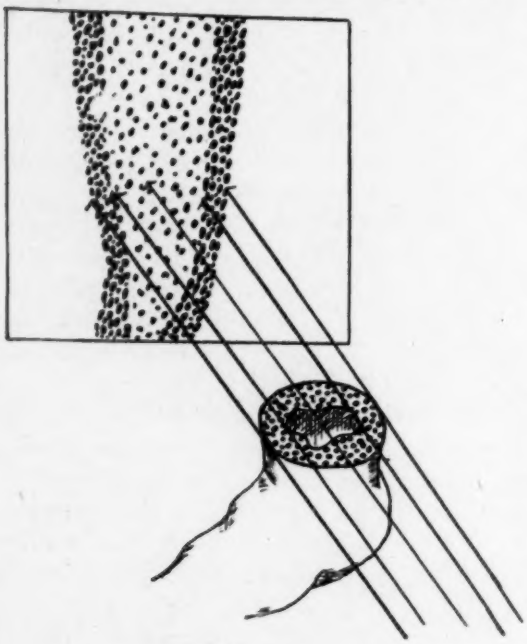


FIG. 5. Diagrammatic representation of stomach and roentgenograms.

per cent of all blood stream invasions in their patients were due to this organism. It is noteworthy that various authors in clinical and experimental observations found that a combination of two or more organisms, for instance *B. coli* and *B. proteus*, may be necessary in the development of gaseous phlegmon.[17]

It is conceivable that the necrotic mucous membrane of the stomach of our patient facilitated invasion and growth of various organisms, among which *B. proteus* and *A. aerogenes* may have been of importance in the formation of the gas, which could be demonstrated roentgenologically.

ROENTGENOLOGIC DIAGNOSIS

The roentgenologic diagnosis of emphysematous gastritis depends upon the demonstration of gas formation in the wall of the stomach. It is important to differentiate gas shadows located in the gastric wall from bubbles dispersed through the visceral contents. If the stomach contains fluid material, the gas-containing stomach wall will be of sufficient contrast to be recognized as a zone of decreased density. Figure 5 illustrates that those roentgen rays which tangentially penetrate the stomach wall will encounter a greater number of gas-filled vesicles than the rays which traverse the visceral wall at right angles. Consequently in survey anteroposterior roentgenograms the curvatures and fundus of the stomach will appear as mottled bands of decreased density in contrast to the surrounding abdominal organs and gastric contents. This is clearly visualized in the roentgenograms in Figures 1 to 4. Examinations in recumbent and upright position will establish that the gas cysts maintain constant position regardless of posture. Once the diagnosis has been suspected from survey roentgenograms it can easily be confirmed by oral contrast media which will permit exact localization of the visceral lumen. These observations should be equally valuable in the recognition of emphysematous inflammations of other hollow viscera.

Roentgenologically, emphysematous gastritis may resemble to a great extent a condition called pneumatosis intestinalis cystoides, to which it may be related. This is characterized by the formation of gas vesicles in the intestinal wall and is most commonly observed in the small intestine. Its etiology is not fully understood. Most recent publications agree that the gas formation is not due to direct bacterial action as shown by the absence of inflammatory reactions on histologic examination.[8] Frequently this process is observed in association with chronic gastric and duodenal ulcer and it has been suggested that mechanical factors such as overdistention of the intestine and obstruction may be the cause of true interstitial emphysema. Pneumatosis cystoides involving

the stomach has been observed very rarely,[7,13,18] and was recognized roentgenologically in only one instance.[1] Pneumatosis cystoides is usually an incidental finding and does not produce clinical symptoms, provided that it does not lead to mechanical intestinal obstruction such as intussusception. It may disappear spontaneously without demonstrable changes in the intestinal lumen.[2] Contrary to this finding, emphysematous gastritis, representing a phlegmonous inflammation of the stomach wall, should be associated with marked clinical symptoms and result in significant deformity of the stomach and scar formation. This was observed in our patient.

SUMMARY

1. Emphysematous gastritis is a phlegmonous inflammation of the stomach caused by gas-forming bacteria.

2. A case of emphysematous gastritis following a suicide attempt with concentrated hydrochloric acid is described. Extensive gas formation in the stomach wall was demonstrated roentgenologically for a period of approximately four weeks. The roentgenologic signs of emphysematous gastritis and its differential diagnosis are discussed.

3. It is believed that the destruction of the gastric mucous membrane facilitated invasion of the submucosal layers by bacteria. It was not possible to make direct bacteriologic studies of the stomach wall. *B. proteus* cultured from aspirated stomach contents and *A. aerogenes* cultured from the blood stream may have participated in the emphysematous infection of the stomach.

Grady Hospital,
Atlanta 3, Ga.

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DIAGNOSTIC PROBLEMS IN FRACTURES OF THE FOOT AND ANKLE

By CAPTAIN DANIEL WILNER
MEDICAL CORPS, ARMY OF THE UNITED STATES

A SUSPECTED bone injury is undoubtedly among the more common conditions encountered at the station hospitals which tax the ingenuity of the roentgenologist. He must not err by failing to diagnose a fracture which is present, nor should he inaccurately read into the roentgenogram a fracture which does not exist.

Gross fractures are of course obvious, but an alteration in the contour of a bone simulating a fracture may be due to a condition which is entirely normal for that individual. A thorough knowledge of roentgen anatomy and surgical pathology is essential for the proper evaluation of such conditions.

Improper roentgen diagnosis in problems of this type leads not only to direct harm to the patient because of prolonged fixation but also to the loss of man power secondary to his disability.

FIG. 1. Periostitis ossificans (retouched).

It is the purpose of this paper, therefore, to demonstrate some of the so-called pseudofractures and true fractures which occur commonly in the bones of the foot and ankle.

PHALANGES

The folds of skin and underlying soft tissues of the toes are frequently superimposed on the phalanges and may produce an apparent discontinuity in the phalanx over which they are projected, thereby simulating a fracture.

A. *Terminal Phalanges.*
   1. Fractures of the terminal phalanges of the second, third, fourth, or fifth toes are unusually rare.
   2. A fracture of the conjoint second and third phalanges of the fifth toe is sometimes seen and should not be confused with a joint fissure.
   3. The terminal phalanx of the great toe being large and unflexed is subject to crushing injuries so that fractures of that bone are readily demonstrated.

B. *Middle Phalanges.*
   1. Fractures of the middle phalanges are comparable to the terminal phalanges in that they occur so infrequently.
   2. A little sesamoid bone is normally found at the plantar surface of the interphalangeal joint of both great toes.

C. *Proximal Phalanges.*
   1. Fractures of the proximal phalanges occur commonly, particularly so in the first and fifth toes.
   2. A shadow, peculiar to a periostitis, altering the plantar contour of the

larger phalanges is often seen as illustrated in Figure 1. This has been explained in the literature as a periostitis ossificans and has been regarded as a sign of flatfoot. Very often this periosteal proliferation is misinterpreted as an old healed fracture. This finding, however, is quite a normal one and may similarly be seen in the fingers, although not as pronounced.

METATARSUS

A. *Differential Diagnosis between Epiphyseal Lines and Fractures.*

1. The union of the epiphysis with the diaphysis takes place in the female between the fifteenth and seventeenth years of life while in the male it occurs between the seventeenth and twenty-second years of life. Before this bony union has taken place, the epiphyseal lines will often stand out and be looked upon as fractures, particularly if tenderness is elicited at the same site. This mistake in diagnosis is even more often encountered in the younger epiphyseal lines which are fairly irregular. The following tabulation, after Ferguson and Goldhamer and Swanberg, is a summary of the differential points:

Epiphyseal Line	*Fracture Line*
a. Of even width throughout.	Is often wider on one end than the other.
b. The contour is usually smooth and regular.	The contours are rugged and irregular.
c. The edges are rounded.	The edges are sharp.

2. The differential diagnosis becomes increasingly difficult when there is an old injury where non-union of the fragments is suspected. Here, as in epiphyseal lines, the contours may be smooth and the edges rounded, but the presence of reparative signs, such as sclerosis and callus formation in case of fracture should make the diagnosis certain.
3. Again, the epiphyseal lines may persist throughout life as a result of general endocrine disturbances or some unknown local cause. Such conditions should be borne in mind and their presence should not be misinterpreted as fractures.

B. *Differential Diagnosis between Accessory Bones and Fractures.*

Numerous accessory bones are regularly encountered in the foot and definitely represent the most common cause for error in diagnosis of the fractures of the foot (Fig. 2).

These accessory ossicles arise from separate centers of ossification representing persistence of "embryonic vestiges which usually disappear" (McGregor). Other accessory bones are due to an abnormal division of usually solitary ossification centers or to a failure of centers of ossification to unite.

It should be laid down as a golden rule of roentgenology "that if any unusual bone deposit is shown in the foot, whether it is a separate shadow or whether it is caused by an unusual projection from an otherwise normal bone, care should be taken in reaching a definite diagnosis, and the possibility of an accessory bone, separate or incorporated, should be considered."

The underlying principles in the differential diagnosis are:

1. To become familiar with the usual sites of these ossicles.
2. To study their configuration as well as the outline of the adjacent bones.
3. To compare with the opposite side when in doubt since these bones

are usually bilateral, although this is by no means a rule. If bilateral, they are not necessarily of the same size or shape in both feet.

4. Never to pronounce a small bone mass as a fracture unless a corresponding defect has been demonstrated in the bone from which the fragment is supposedly derived.

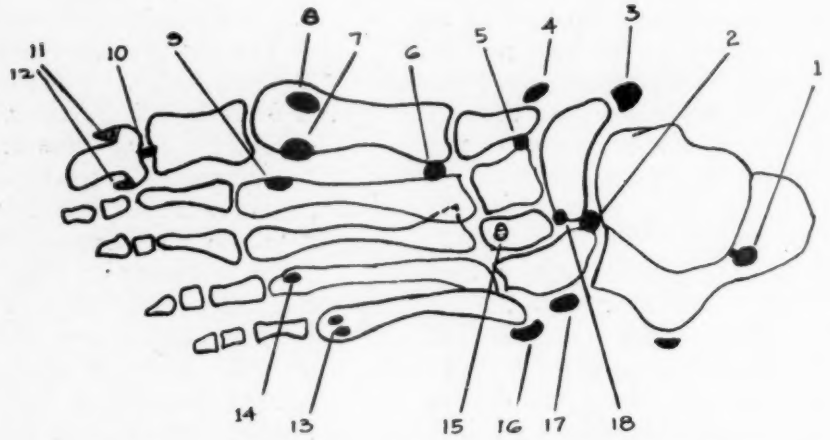


Fig. 2*A*. Accessory bones of the foot (after Holland).
1. Os trigonum
2. Secondary os calcis
3. Tibiale externum
4. Paracuneiform
5. Intercuneiform
6. Intermetatarseum
7. External flexor hallucis brevis sesamoid
8. Internal flexor hallucis brevis sesamoid
9. Second toe sesamoid
10. Interphalangeal big toe sesamoid
11. Spurs on terminal phalanx
12. Spurs on terminal phalanx
13. Fifth toe sesamoid
14. Fourth toe sesamoid
15. Os uncinatum
16. Os vesalianum
17. Os peroneum
18. Secondary cuboid

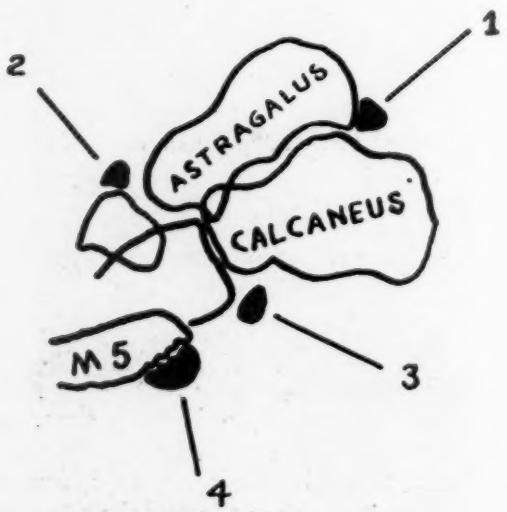


Fig. 2*B*. *1*. Os trigonum
2. Talonavicular ossicle
3. Os peroneum
4. Os vesalianum

5. To look for the presence of a cortex since the ossicle has a cortex on every surface; whereas the fracture fragment has no cortex on at least one surface.
6. To look for the presence of reparative signs when a time interval has elapsed.
7. To compare the characteristics of contour and texture of fractures with the outline and structure of accessory bones before deciding on a definite diagnosis.

FIRST METATARSAL

A. The epiphysis is located at the proximal end of the first metatarsal in contrast to the distal epiphysis of the remaining metatarsals.
B. The proximal epiphysis occasionally

presents a fissure in its middle which should not be mistaken for a fracture. It is usually found bilaterally.

Fig. 2*C*. The os vesalianum, a separate element clearly seen at the proximal and external part of the tuberosity of the fifth metatarsal in a soldier, aged twenty-two. It represents a separate ossification center consisting of a large part of the tuberosity which persists through life. This is an unusually rare ossicle, only isolated cases having been described in the literature. It is usually bilateral as demonstrated in Figure 2*D*. There is no suspicion of injury since the roentgenogram was taken on acount of pain in the ankle joint.

C. A pseudo-epiphysis may occur at the head of the first metatarsal and likewise simulate a fracture.

D. The intermetatarseum, a small and rather rare ossicle, is situated between the bases of the first and second metatarsals. More often it is seen as an elongation from the outer distal angle of the internal cuneiform and occasionally it may be fused with the base of the first or second metatarsal (Fig. 3).

Fig. 2*D*. Same case as Figure 2*C* showing the os vesalianum visible on both sides.

SECOND, THIRD, FOURTH, AND FIFTH METATARSALS

A. The sesamoid bones are commonly seen on the plantar side of all the metatarsal bones with the exception of the third (Fig. 2).

B. Double sesamoids or congenital bipartite sesamoids occur quite frequently, a good example of which is

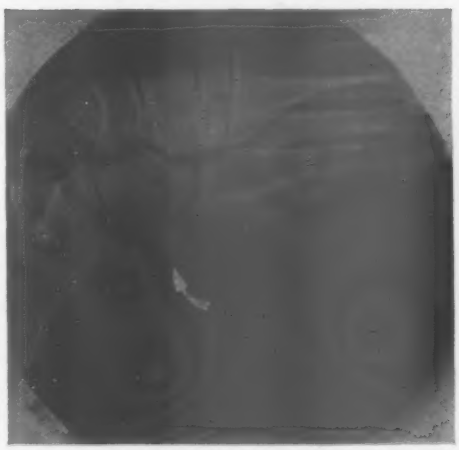
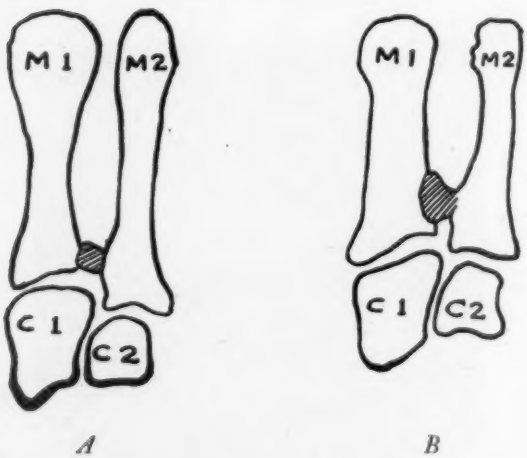


Fig. 2*E*. An avulsion type of fracture at the base of the fifth metatarsal.

Fig. 3′. Osteochondritis of the distal end of the second metatarsal (Freiberg's infraction).

the bipartite medial sesamoid bone seen in the metatarsal phalangeal joint of the great toe (Fig. 4*A*). However, this same sesamoid bone may show a fracture and present strong clinical evidence to that effect. The differential diagnosis becomes even more difficult in cases with recent history of trauma because the same findings may exist in both conditions; namely, a smooth, dense, well defined contour with absence of displacement. For such cases, a useful method in studying the sesamoid bones under the first metatarsal head, and in viewing the plantar surfaces of the metatarsal heads is illustrated in Figure 4*B*.

Fig. 3*C*. Fusion of the first and second metatarsals.



A *B*

Fig. 3*A*. Os intermetatarseum.
Fig. 3*B*. Os intermetatarseum fused to base of second metatarsal (after Dwight).

C. A sesamoid bone, os vesalianum, is occasionally seen in the lateral portion of the proximal end of the fifth metatarsal. This osseous nucleus makes its appearance in the tendon of the peroneus brevis muscle between the thirteenth and fourteenth years of life, ossification being complete at sixteen years (Fig. 2). A crack fracture of the tuberosity at the base of the fifth metatarsal or an avulsion type of separation of that fragment of bone may occur as a result of a severe inversion strain of the foot initiating a contraction of the peroneus brevis muscle which has its insertion in the tuberosity. The

history and roentgen appearance aid in determining the correct diagnosis (Fig. 2*C*).

D. A march fracture is a condition involving the distal portion of the shafts of the second, third, or fourth metatarsals. It is characterized by a localized prolific overgrowth of periosteal new bone. The patient usually does not recall any injury or strain. The initial crack in the bone is so fine that roentgenograms taken during the first few days may fail to disclose it. The periosteal thickening is always related to the insertion of the interosseous muscles. This condition is more frequently encountered in members of the Armed Forces whose duties require them to be on their feet for long periods of time. This overgrowth of cortical bone has been confused with a malignant condition.

E. The lateral margin of the proximal end of the fifth metatarsal usually projects considerably to the side, beyond the limits of the cuboid bone and should not erroneously be called a subluxation.

Fig. 4*A*. Epiphyseal line in a congenital bipartite sesamoid at the first metatarsal head.

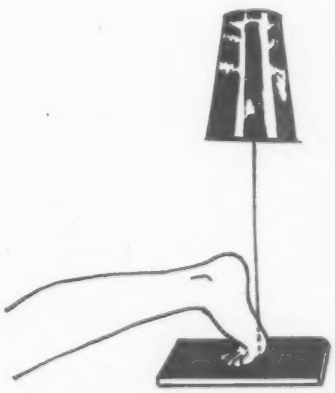


Fig. 4*B*. Special view to visualize sesamoid bones under first metatarsal head.

F. An osteochondritis of the distal end of the second metatarsal (Freiberg's infraction) is occasionally encountered (Fig. 3′). The head of the bone becomes flattened or even concave and may be irregular in outline and increased in density. The adjacent portion of the proximal phalanx is likewise increased in width but the joint space is not affected. This deformity should not be mistaken for an old impacted fracture at the head of the second metatarsal.

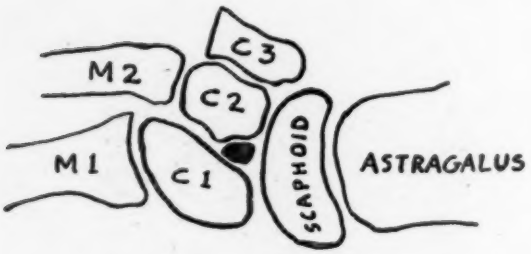


FIG. 5*A*. Os intercuneiforme.

FIG. 5*B*. Os paracuneiforme (after Cameron).

FIG. 6*A*. Different forms of os peroneum at the plantar angle of the cuboid bone. Cortex is visible on every surface. Sharp line of demarcation. No defect is present in the adjacent bones as would be seen in a fracture.

CUNEIFORM BONES

A. The superimposition of the shadows of these bones, together with the irregularity caused by the projection of these bones beyond the cuboid, scaphoid and metatarsal bones, makes the diagnosis of fracture quite difficult.

1. A subdivided first cuneiform has been mentioned as occurring bilaterally. Fusion of this divided bone can occur several years later.
2. A broad articular fissure may occasionally be demonstrated between the first and second cuneiforms, which, with a history of injury at that site, may be mistaken for a fracture.
3. The os intercuneiforme, seen by Dwight on two occasions, is a small wedge-shaped bone which is situated on the dorsum of the foot just distal to the scaphoid and separates the proximal parts of the internal and middle cuneiform bones (Fig. 5*A*).
4. The os paracuneiforme, seen by Cameron on two occasions, is situated on the medial aspect of the foot in the angle between the scaphoid and internal cuneiform bones (Fig. 5*B*).
5. The os uncinatum, seen twice by Froehlich, is located on the plantar surface of the external cuneiform bone and may either be an isolated ossicle or attached on the distal end by a hook-like process (Fig. 2).
6. A congenital fusion of the second and third cuneiforms with the metatarsal bones has been described.

B. It is to be remembered that any change in the angle of the projection, even of the slightest degree, im-

Fig. 6*B*. Os peroneum divided into three small fragments.

Fig. 6C. Os peroneum articulating with the inferior surface of the calcaneus which may easily be mistaken for a chip fracture.

mediately presents a marked change in the roentgen appearance.

CUBOID BONE

A. Of this bone, there would be nothing to say were it not for the presence of two accessory ossicles within its confines.

1. The os peroneum, commonly known as the sesamoid in the tendon of the peroneus longus, occurs in less than 10 per cent. It lies along the external border of the cuboid bone near the posterior calcaneal articulating surface. It varies in size from a mere dot up to a shadow measuring 2 cm. in length. It may appear flattened semicircular or crescentic in shape (Fig. 6*A*), and may even be subdivided (Fig. 6*B*). Occasionally this ossicle may be seen articulating with the inferior surface of the cuboid or the adjacent surface of the calcaneus which may be easily confused with a chip fracture as illustrated in Figure 6*C*. The fact that the os peroneum is almost always seen in both feet, although not necessarily of the same size and shape, aids considerably in the final diagnosis.

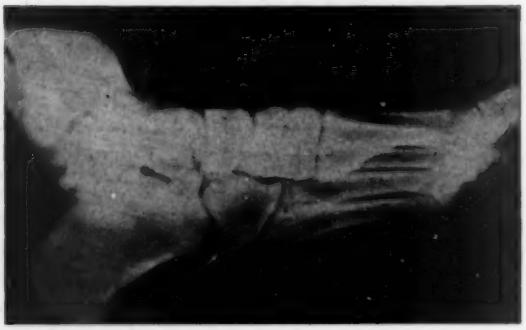


Fig. 6D. Chip fracture of the inferior surface of the cuboid.

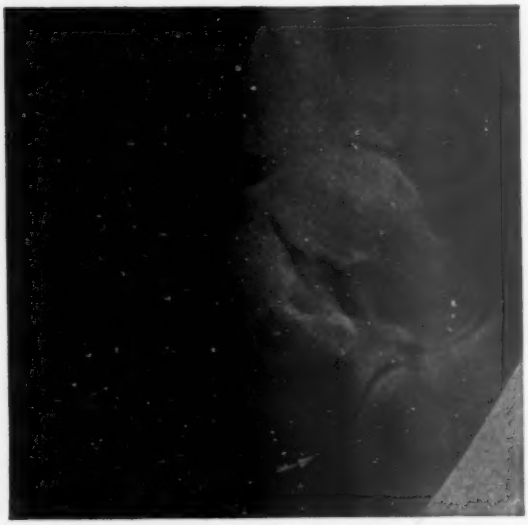


Fig. 6E. Chip fracture of the plantar surface of the cuboid. It is to be noted that fractures of the tibia and fibula are also present.

2. The secondary cuboid, despite its name, is more closely associated with the scaphoid than with the cuboid, since if fused to either of these bones it is found to be

more frequently fused to the scaphoid. This is a very rare bone indeed and is represented by a small circular shadow in the sole of the foot closely related to both the scaphoid and cuboid bones (Fig. 7).

B. Routine views permit good visualization of the cuboid; however, for visualization of the secondary cuboid, roentgenograms are taken with the sole of the foot down since the lateral view presents too many conflicting shadows.

SCAPHOID BONE (NAVICULAR BONE)

A. Isolated fractures of this bone are quite rare and when seen they usually accompany other fractures. Köhler states he has seen only 12 such fractures.

1. An elevation of the articular margins is seen rather regularly in patients with flat feet and in fractures of the os calcis. It is usually associated with a bony swelling of the articular end of the astragalus opposite to it which is usually even larger. This is believed to represent a functional adaptation to the valgus position of the foot and in the most pronounced cases an arthritis deformans may be considered.
2. The os tibiale externum (accessory scaphoid), a sesamoid in the tendon of the tibialis posterior, is seen in about 10 per cent of cases along the medial margin of the proximal

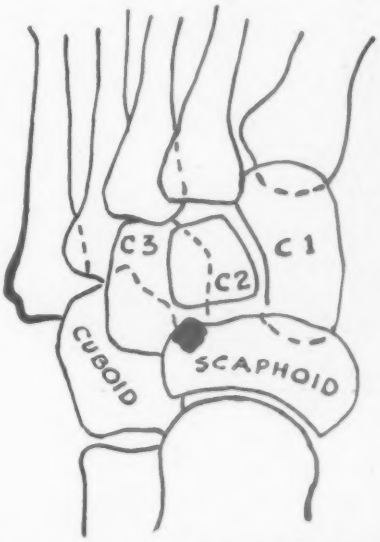


FIG. 7. Secondary cuboid (after Holland).

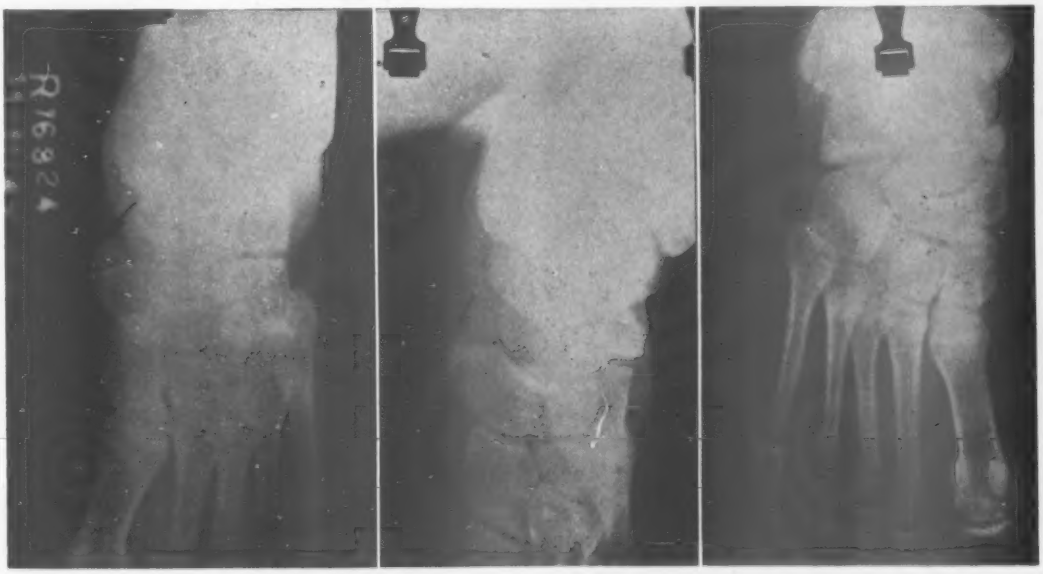


FIG. 8. Different forms of tibiale externum which may be mistaken for a fracture. The line of demarcation from the scaphoid has the features of an epiphyseal line.

Fig. 9*A*. Talonavicular ossicles at the dorsal aspect of the navicular bone. Cortex is present on every surface. No defect is present in the adjacent bones.

Fig. 9*B*. Chip fractures at the dorsal aspect of the navicular bone. The defect from which the fragment originates is devoid of cortex. The line of demarcation is a fracture line.

articulating end of the scaphoid and has a very definite relationship to the tuberosity of this bone (Fig. 8). It is represented by a portion of scaphoid bone which envelops the internal aspect of the talus bone by 1 to 2 cm. and which is separated from the scaphoid proper by a transverse fissure. Occasionally it may present a small fragment about the size of a pea compared to a good sized ossicle on the opposite side. This accessory bone is frequently mistaken for a fracture of the tuberosity of the scaphoid for the following reasons: (*a*) the presence of a prominence on the inner side of the foot; (*b*) pain and tenderness may occasionally accompany the presence of this ossicle; (*c*) the fact that the injured side may present the transverse fissure while the healthy side shows the acces-

sory scaphoid completely united; (*d*) history of muscular violence (injury).

3. The talonavicular ossicle (astragaloscaphoid) is uncommonly seen as a small fragment of bone on the dorsum of the foot between the upper edges of the talus and navicular bones. It may be present as a distinct ossicle or may be fused either to the talus or navicular bones (Fig. 9*A*).

   Chip fractures also may be seen at the same site as a result of ligamentous or tendinous tears (Fig. 9*B*).

   The differential diagnosis between a fracture, accessory ossicle, or a localized osteoarthritis at this site may at times present quite a problem.

4. Köhler's disease is a condition characterized by the retardation of osseous development of the scaphoid bone. The ossification center for this bone remains small and irregular in outline as a result of certain changes, the exact nature of which is not fully understood. This disorder is thought by some to represent an avascular (aseptic) necrosis, possibly the result of some endocrine disturbance accompanied by the stress and strain of weight bearing or heavy muscular pull, for the ultimate interference with the blood supply leading to disturbance in local nutrition. This disease is usually bilateral and is self limited.

B. Routine roentgenograms ordinarily permit good visualization of this bone. However, in order to see the accessory bones distinctly, the following views are employed: (1) The tibiale externum is best seen by placing the sole of the foot down on the film and extending the ankle. The central ray is directed downward to a point midway between the tips of the two malleoli. (2) The talonavicular ossicle is best seen in a direct lateral view.

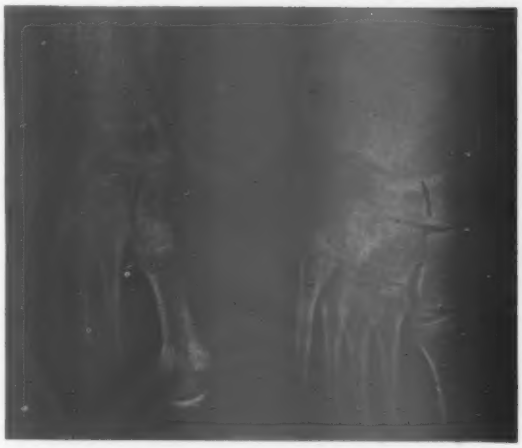


Fig. 10. A fracture of the inferior part of the talus which is represented by a faintly visible interruption in the normal convexity of that portion of the bone.

ASTRAGALUS OR TALUS BONE

A. This bone is very variable in respect to its general conformation. It is subject to fractures, numerous anatomical alterations in contour, accessory bones and inflammatory conditions which offer their respective problems in diagnosis.

1. Fractures of the inferior part of the astragalus are not too common and usually cause no difficulties in diagnosis. Figure 10 presents a fracture of the inferior part of the talus which is merely represented by a faintly visible alteration in the normal convexity of that portion of the bone, which could very easily be overlooked.
2. Fractures of the neck are common and are usually complete.
3. Compression fractures are rare and difficult to diagnose. In a profile view, a compression fracture may be confused with a normal low astragalus. Comparison

Fig. 11. Trochlear process near the head of the astragalus which is frequently fractured.

with the other side will be a valuable aid in the diagnosis.

4. The free dorsum of the talus is normally concave. Occasionally, ridges and processes may occur and actually cause local symptoms to suggest a fracture. Figure 11 shows the trochlear process near the head of the astragalus, a bony outgrowth projecting upwards from the anterior and upper end of the astragalus. There have been lengthy discussions as to its clinical significance. It should be noted that these processes, whether definitely pathological or otherwise, may be fractured.

5. The hind part of the astragalus is drawn out backward into a projection which is grooved by the flexor hallucis longus muscle. Along the outer border of this groove is the posterior external tubercle (posterior process). The inner border may be very ill defined or may be marked by the posterior internal tubercle (internal process).

The posterior process can be seen in the lateral view as a bony prominence arising from the dorsal aspect of the astragalus. This process may break off easily, particularly after long marches and may show no apparent displacement. This fracture may also accompany a crush fracture of the os calcis or it may complicate a subastragaloid mid-tarsal dislocation of the foot. This fracture must be distinguished from the congenital variation observed in about 10 per cent of normal individuals in which the posterior tubercle develops as a separate ossicle known as the os trigonum (Fig. 12). The differential diagnosis is as follows:

Os Trigonum

a. A round oval or three-cornered shadow 1 cm. in diameter with sharp and well defined edges, plus equal spacing along the division of the ossicle and adjacent talus bone.
b. Occurs bilaterally, although it may vary in size and shape in the two feet.

Fracture of Posterior Process

a. A small triangular shadow separated by a narrow ill defined fissure from the rounded off posterior process.
b. Is unilateral. The healthy foot shows a process without a line of fracture.

Note: It is to be borne in mind that a fracture of the posterior process may exist simultaneously with an os trigonum.

Very rarely, instead of the os trigonum being either a prolongation from the astragalus or a separate bone, it may be fused to the upper surface of the os calcis.

Anatomically, a large internal process of the astragalus may rarely be seen and is represented

Fig. 12*A'*. The os trigonum, instead of being a prolongation of the astragalus, is situated on the upper surface of the os calcis.

by an exaggerated hook-like internal tubercle. It is questionable whether this can be distinguished in the roentgenogram from an os trigonum. Possibly this might be done by taking lateral views from both sides.

6. The astragalus secondarius, a small oval ossicle lying above and behind the head of the astragalus near the anterior portion of the neck, has been found once and described by M. I. Bierman (Fig. 13).
7. A spindle-like dense shadow in front of the head of the astragalus seen in the lateral view is due to the overlapping of the shadow of the scaphoid and is not to be confused with any fracture line.
8. The astragalus may be involved

Fig. 12*A*. Different forms of os trigonum at the posterior aspect of the astralagus.

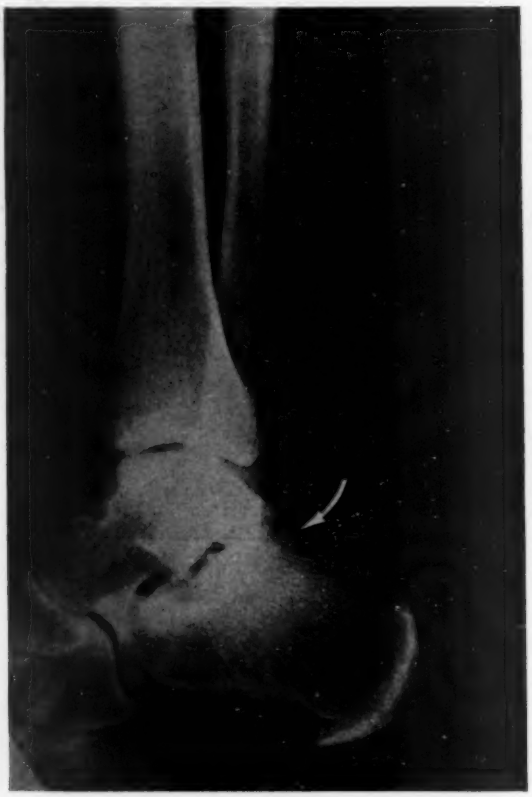


FIG. 12*B*. An avulsed fragment of bone (chip fracture) arising from the posterior process of the astragalus. There is no cortex on the surface which fits the defect.

FIG. 12*D*. The posterior process of the astragalus is broken off as evidenced by the irregular ragged margins and the filling defect at the posterior aspect of the astragalus which represents the site of origin of the fragment.

FIG. 12*C*. Chip fracture of the posterior process of the astragalus, the fragment being displaced posteriorly into the soft tissues.

in several pathological conditions which might lead to the erroneous conclusion that they occur secondarily to trauma.

Osteomyelitis, tuberculosis, osteochondritis dissecans, osteitis fibrosa cystica and neoplasms such as giant cell tumor and metastatic adenocarcinoma have been described in this bone by Lewis.

Osteochondritis dissecans is a condition occurring in young adult

FIG. 13. Astragalus secondarius (after Bierman).

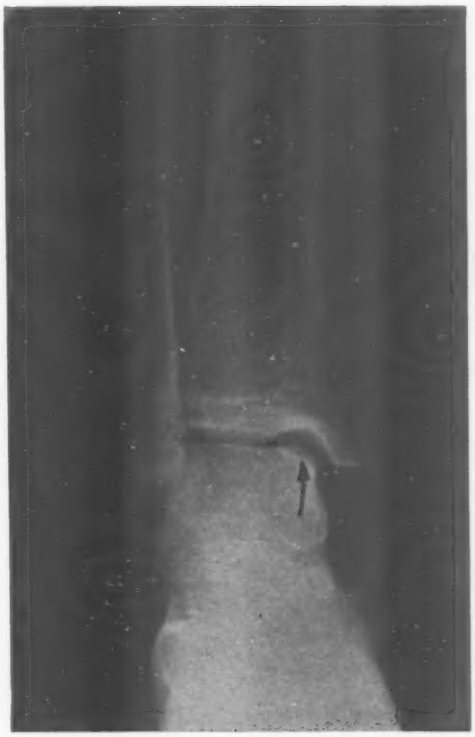
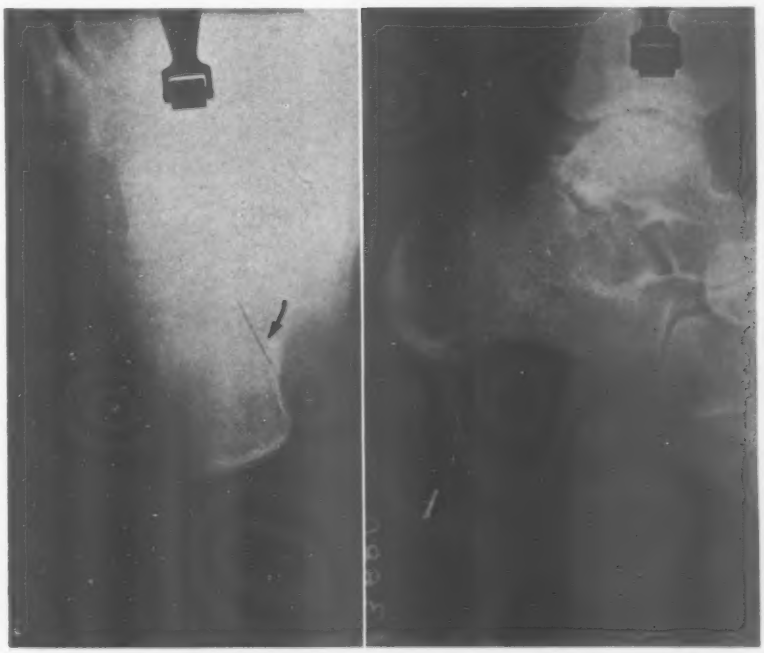


Fig. 14*A*. Osteochondritis dissecans.

Fig. 14*B*. Chip fracture of the superior internal articular margin of the astragalus.



A *B*

Fig. 15. Oblique fracture of calcaneus (retouched) (*A*) which cannot be seen on the routine lateral view (*B*).

life, characterized by a localized aseptic necrosis of cartilage and underlying bone. It is not associated with pyogenic infection but is most commonly caused by

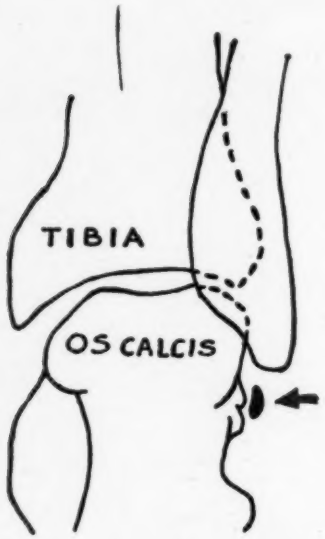


Fig. 16. Separate ossification in relation to the peroneal process of the os calcis (after Holland).

an interference with the blood supply to the affected area as a result of trauma. Roentgenographically, it is characterized by a partial or complete separation of a crescentic or triangular area of bone from the articular surface of the joint. It is separated from the main bony structure by a zone of rarefaction. At the onset, the fragment is held in place by the intact cartilage but later on, this may also give way and the fragment of bone may become detached and appear as a loose body in the joint, commonly known as a "joint mouse." Figure 14*A* illustrates this condition occurring in the superior medial articular surface of the astragalus which is very often mistaken for a fracture.

os calcis (calcaneus)

A. This bone is fractured more frequently than any of the tarsal bones and comprises 1 to 2 per cent of all fractures. A special view should be taken for suspected fractures of the calcaneus because very often a prominent fracture may be overlooked if only the routine views are employed (Fig. 15). Roentgenograms are taken with the patient standing on the film, the knee slightly flexed and the tube set behind the calf.

1. The peroneal process of the os calcis (process trochlearis of German anatomists) is a small ridge on the outer side of the os calcis separating the tendons of the peroneus longus and brevis. Roentgenographically, it occasionally reaches such a size that it may be mistaken for an exostosis. A small oval fragment of bone is rarely encountered below the tip of the external malleolus but from its position and shape, it is obviously not caused by an ossification

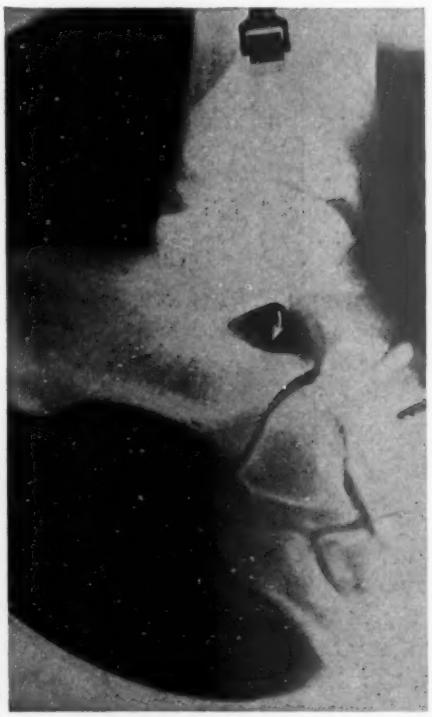


Fig. 17. Chip fracture of sustentaculum tali of os calcis.

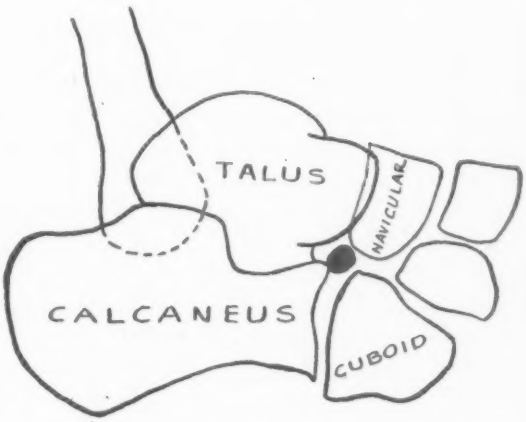


FIG. 18*A*. Secondary os calcis (after Holland).

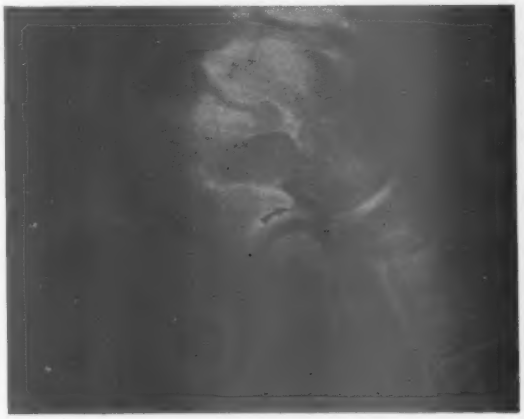


FIG. 18*C*. An old partially healed chip fracture at the anterior superior articular surface of the os calcis. The fracture line is still faintly visible.

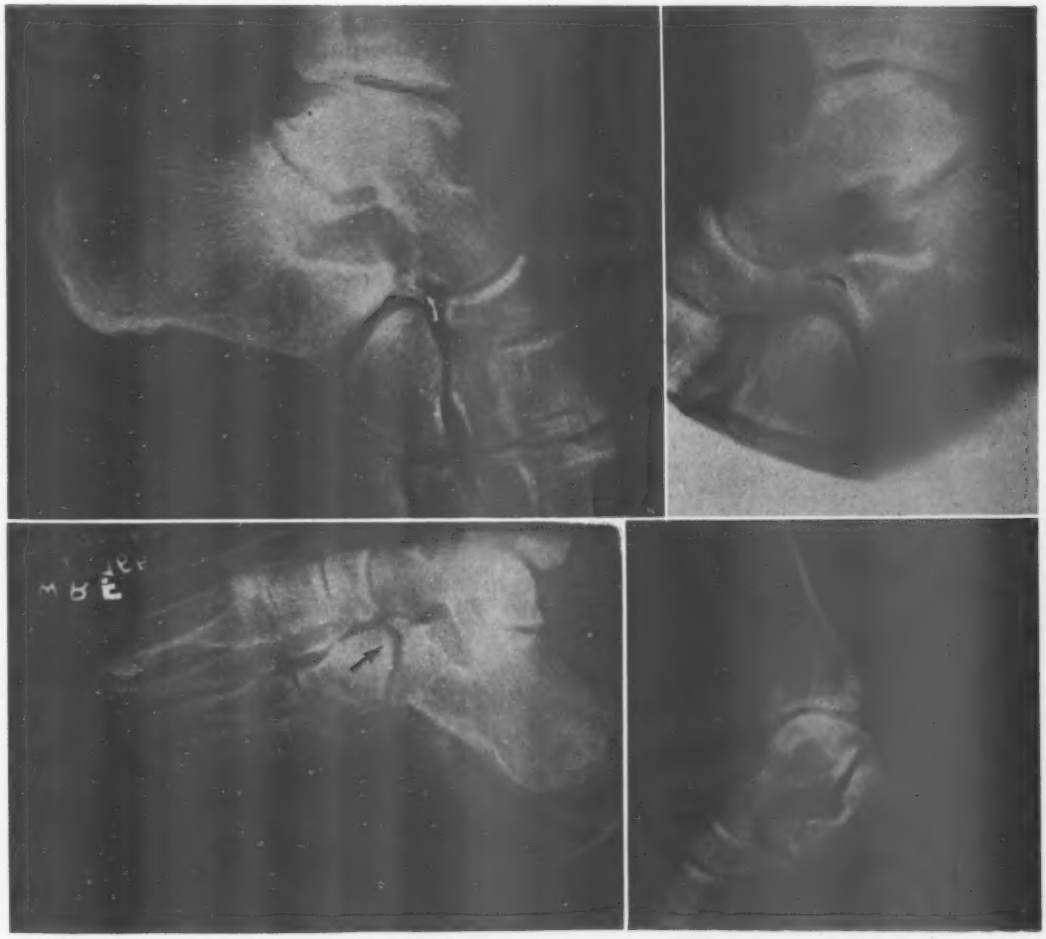


FIG. 18*B*. Chip fractures of anterior superior articular surface of the os calcis.

of an unfused epiphysis of the tip of the fibula. It is possible that this represents a separate ossification having some relationship to the peroneal process of the os calcis (Fig. 16).

2. The sustentaculum tali is a shelf-like process which projects from the anterior portion of the medial surface and overhangs the groove in this surface. A fracture at this site occurs very infrequently, being caused by the forcible inversion of the foot with the result that the sustentaculum is compressed against the inferior surface of the astragalus and is either broken off or compressed into the body of the bone. The roentgenogram of such a fracture is apt to be negative, as the sustentaculum is difficult to show. Such a fracture is best visualized in an oblique view of the ankle in 45 degrees internal rotation making certain that the ankle is rotated inward and not just the foot (Fig. 17).

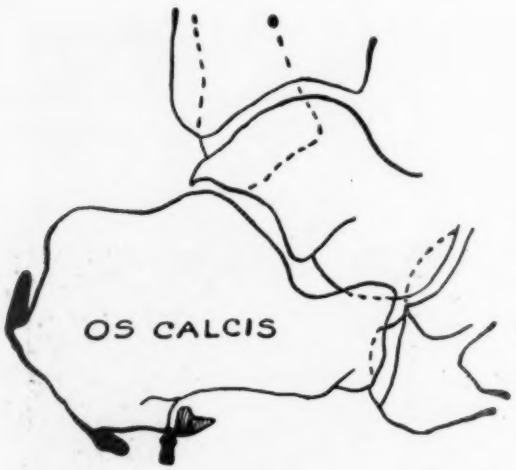


FIG. 19. Common site for spurs. Arrow points to a fractured spur.

3. The secondary os calcis, although somewhat rare, is situated on the dorsum of the foot, being closely related to the os calcis, the astragalus, the scaphoid, and the cuboid (Fig. 18*A*). This sesamoid is visualized roentgenographically by placing the inner side of the foot on the film with the outer side raised so that the sole of the foot makes an angle of 30 to 40 degrees with the film. Such a roentgenogram will show a clear space between the os calcis, astragalus, cuboid, and scaphoid bones.

4. Spurs appear commonly on the os calcis but are not always the cause of symptoms. The most frequent site of occurrence is the under surface of the os calcis, just in front of the heel proper at the insertion of the plantar fascia. These spurs are not infrequently fractured but occasionally they may appear separated and thus simulate a chip fracture while actually they are connected by fibrous tissue which cannot be seen on the roentgenogram (Fig. 19).

DISTAL ENDS OF THE TIBIA AND FIBULA

A. *Tibia.*

1. A fracture may be difficult to diagnose in the following normal conditions:

a. The most distal part of the medial malleolus has a much smaller sagittal diameter than its proximal part, thereby producing contrasting shadows of paleness and denseness in the routine posteroanterior view.

b. If the inner border of the foot is not quite perpendicular to the table, the most distal end does not pass evenly into that of the upper part. Consequently, a fissure fracture may be easily overlooked.

c. A detachment of the posterior edge of the tibia can be missed because the separation is usually slight and the line of fracture may be completely hidden by the superimposed shadow of the fibula.

2. A variety of shadows of increased density may be seen in the vicinity of the distal end of the tibia which may represent either: a, post-traumatic ossification of the torn calcaneotibial and talotibial ligaments; b, peri-arthritic deposits; c, calcifications of the posterior tibial artery, or d, an accessory ossicle, the os subtibiale.

a. *Post-traumatic ossifications of torn ligaments:* (1) These calcifications occur

rather frequently and must not be confused with avulsion fractures. These deposits occur at the site of attachments of tendons and ligaments. (2) A spicule-like fragment may be seen along the posterior aspect of the distal end of the tibia (Fig. 20), which is to be considered either as a

Fig. 20*A*. A spicule-like fragment which represents a calcification of the posterior malleolar ligament secondary to trauma. This is similar to a dense calcareous band in the tibial collateral ligament (Pellegrini-Stieda's disease).

calcification of the posterior malleolar ligament secondary to trauma, or a tearing off of the posterior malleolar ligament, together with the periosteum proximal to it with subsequent ossification. This is similar to the dense calcareous band deposited in the tibial collateral ligament along the inner side of the knee joint (Pellegrini Stieda's disease).

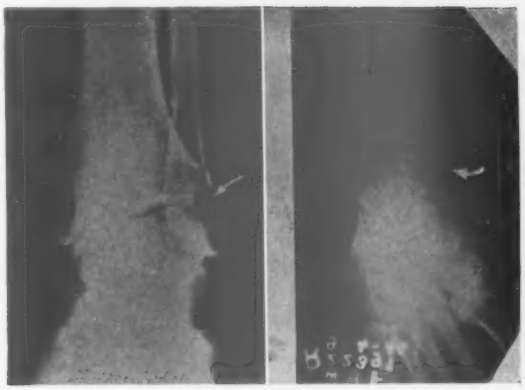


Fig. 20*B*. Peri-arthritic deposits.

b. *Peri-arthritic deposits:* These deposits are amorphous in character, lack any bone detail, and the bone from which they are supposed to originate shows no defect in outline (Fig. 20*B*).

c. *Calcifications in veins and arteries:* Calcareous deposits occur in the walls of the veins especially where they are subjected to trauma or constant ir-

Fig. 21. Calcification of the posterior tibial artery (retouched).

ritation. These deposits have a spherical or oval outline and are situated in the soft tissues anterior to the tibia. Calcifications of the posterior tibial

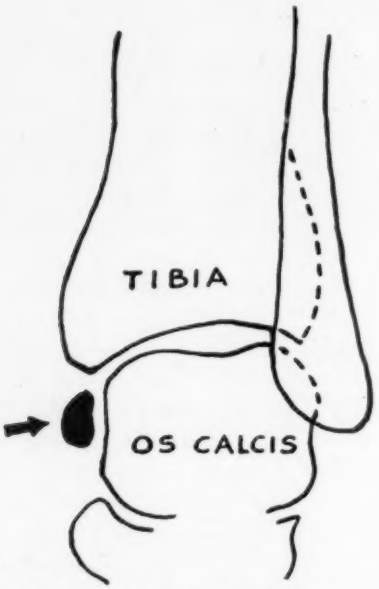


Fig. 22. Os subtibiale (Fairbank).

artery have a double contour consisting of thin parallel lines which are wavy and not completely continuous. They are usually seen above the os calcis and behind the tibia and fibula (Fig. 21).

d. *Os Subtibiale:* A small fragment of bone just distal to the internal malleolus may be recognized as the accessory ossicle of the calcaneotibial ligament and is known as the "os subtibiale" (Fig. 22). This is a distinct entity which is not due to trauma, but in some cases may be difficult to differentiate from trauma.

3. Light transverse lines may occasionally be seen running parallel to one another in the spongious portion of the distal end of the tibia. These represent irregular intermittent ossifications dating from youth and are caused by various forms of chronic disease (Fig. 23). They are of no pathological importance.

B. *Fibula.*

1. A fracture in the epiphyseal lines at the distal end of the tibia and fibula is rather rare and can only be diagnosed when the epiphysis is dislocated and rotated about its axis.

2. A fracture of the distal end of the fibula may escape diagnosis both in the posteroanterior and lateral views due to the shadow of the tibia being superimposed on the shadow of the fibula. To correct this

Fig. 23. Light transverse lines running parallel to one another which represent irregular intermittent ossifications dating from youth and are caused by various diseases. They are of no pathological significance.

Fig. 24*A*. Post-traumatic ossifications of the calcaneofibular ligament or peronei tendons.

overlapping of the bones, the tube should be angulated more posteriorly in the lateral profile view and more anteriorly in the medial profile view.

3. A few weeks after a history of trauma, dense shadows may be seen either attached to or partly separated from the lower end of the fibula. These represent post-traumatic ossifications of the calcaneofibular ligament or the peronei tendons (Fig. 24*A*).

Fig. 24*B*. Chip fracture of the distal end of the fibula. The defect from which the fragment is derived is plainly visible. There is an interruption in the normal contour of the cortex denoting a fracture line.

SUMMARY AND CONCLUSIONS

1. The confusing shadows of each bone of the foot are discussed and their anatomical and pathological significance evaluated. A thorough knowledge of roentgen anatomy, including the roentgen appearance of the normal structures, as well as the various anomalies, is essential for the proper evaluation of these shadows.

2. The proper technique of positioning, utilizing special views for individual bones, is a valuable aid in establishing a correct diagnosis.

3. Emphasis is placed on the numerous accessory bones that are regularly encountered in the foot and represent the most common cause for error in the diagnosis of fractures of the foot. The underlying principles in the differential diagnosis

between these ossicles and chip fractures are enumerated. Cases illustrating these accessory ossicles are shown and discussed.

4. Considerable stress is placed on the differential diagnosis between fracture lines and epiphyseal lines. It is to be borne in mind that there may be a delay in the closure of the epiphyseal lines in hypothyroidism and in cases of gonad and anterior pituitary deficiency.

5. The variety of radiopaque shadows seen in the vicinity of the distal end of the tibia and fibula fall under the following classification: (a) post-traumatic ossifications; (b) peri-arthritic deposits; (c) calcifications of arteries and veins; (d) accessory bones. Illustrations of each of these groups are presented and their characteristics discussed.

5600 Gainor Road
Philadelphia, Pa.

I am greatly indebted to Dr. Ernest Lachmann, Professor of Anatomy at the University of Oklahoma Medical School for his valuable assistance and co-operation in the preparation of this paper.

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SOME PROCEDURES FACILITATING ROENTGENOLOGIC INTERPRETATION IN AN INDUCTION STATION

By CAPTAIN ABRAHAM J. FLAXMAN
MEDICAL CORPS, ARMY OF THE UNITED STATES

WHEN interpreting the 4 by 10 inch stereoscopic photoroentgenogram used for the examination of the chest in an induction station, it is often necessary to take a 14 by 17 inch roentgenogram to determine whether some finding in the smaller film is indeed a pathologic condition. Where the number of 4 by 10 inch films runs into many hundreds a day, the processing of men is facilitated for both the roentgenologist and the administrative personnel if the inductee can be sent on his way immediately following the taking of the roentgenogram. It is found, however, that the routine posteroanterior roentgenogram of the chest does not present the same relationship of the ribs to the clavicles nor of the thoracic cage to the parenchyma that is to be seen in the photoroentgenogram. Thus, an unobscured finding in the photoroentgenogram is usually obscured by some bony structure in the routine anterior roentgenogram. This is especially true of suggestive findings in the apical regions, necessitating return of the inductee for further examination and resulting, at times, in misinterpretation. To expedite processing and facilitate interpretation, the following routine procedures are in use at this induction station.

I. Where the finding is seen clearly in either of the stereoscopic views of the photoroentgenogram, in the apical regions as elsewhere, it is best to duplicate its relationship of ribs, clavicles, and parenchyma on a 14 by 17 inch film. The variation in appearance of the two roentgenograms is due to the following factors:

1. The roentgenogram is taken at a 72 inch focal-film distance; the photoroentgenogram is taken with the focal spot at 36–40 inches from the fluorescent screen.

2. In the roentgenogram, the central ray is directed to the center of the film; in the photoroentgenogram, the central ray is directed 1½ inches off center in each of the stereoscopic views.

By proper angulation and elevation or lowering of the tube when taking the roentgenogram, its relative relationship of ribs, clavicles, and parenchyma can be made to duplicate that of the photorentgenogram. The procedure is as follows: The patient and tube are centered to the cassette in the customary manner for an anterior chest. Then, the tube is either —

1. Lowered 4 inches and then tilted 10° upward from the horizontal; or

2. Raised 4 inches and then tilted 10° downward from the horizontal.

Procedure 1 is used to duplicate that view of the 4 by 10 inch film obtained at the lower position of the stereoscopic shift. Procedure 2 is employed to duplicate the view obtained at the upper position of the stereoscopic shift. If the 4 by 10 inch film is held vertically, lung apices superiorly, the upper view is always that obtained at the upper position of the stereoscopic shift, whether the tube shift is upward or downward; conversely, the lower view is produced at the lower position of the stereoscopic shift. This is due to the fact that the lens system of the photoroentgen unit inverts the image produced by the fluorescent screen.

Case 1. Several months after his pre-induction physical examination, a man was sent to this station for immediate induction. To his paper was attached a routine anterior roentgenogram of the chest (Fig. 1) indicating that some irregularity had been noted in his previous photoroentgenogram. On the basis of this roentgenogram, the chest had been considered essentially negative and the individual classified as 1A. Because of the lapse of time since the

FIG. 1. Case I.

former examination, a new physical examination was required. The photoroentgenogram presented an unobscured view of markings in the right apex, and a roentgenogram was taken in accordance with procedure I above (Fig. 2). This view showed a bleb with considerable surrounding infiltration. The inductee was obviously a bad risk and could not be accepted.

II. Where the finding in the photoroentgenogram is obscured by the ribs caudad to the clavicle, the routine anterior roentgenogram of the chest usually brings it into view.

III. Where the finding in the photoroentgenogram is in the apical region and is obscured by ribs or clavicle, the posterior lordotic position,[1] with modification, is used. This position projects the ribs in a horizontal position, and may therefore be used to uncover the apical region. Following the procedure as usually described, the cassette is supported by a vertical film holder which is adjusted to the proper height for the patient. The latter stands with his back to the cassette, hands on hips, shoulders squarely against the cassette holder, feet about 1 foot forward, knees slightly bent, abdomen protruding in a position of lordosis; the central ray is projected horizontally and directed to the center of the cassette. The roentgenogram thus obtained presents an apical-diaphragmatic foreshortening of the lung fields

FIG. 2. Case I.

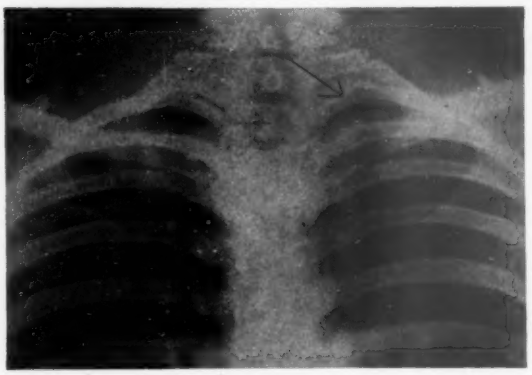

FIG. 3. Case II.

which produces considerable exaggeration and distortion of the lung markings. This position was first described[2] for the visualization of small localized effusions in the interlobar space, and for this purpose a horizontal projection of the central ray is essential. For the study of the apical regions, however, and to compensate for the above-mentioned foreshortening of the lung fields, the following modification is used: The tube is first centered to the cassette in the customary manner; then it is tilted 5° upward from the horizontal and lowered (about 4 inches) until the central ray is again centered to the cassette. This modification also assists in projecting the upper ribs in a more horizontal position, since it projects the anterior ribs upward to a greater extent than the posterior ribs.

Except for the kilovolts (peak) values, the factors in this procedure are the same as for the routine anterior roentgenogram. For chest thicknesses to 28 cm. inclusive, the kilovolts (peak) value used for the com-

parable anterior view is increased by 5. Above 28 cm., the kilovolts (peak) value is increased a minimum of 10. In those cases in which there is calcification of the upper costal cartilages, the posterior lordotic view is not always satisfactory.

Case II. In the yearly examination of Navy personnel at this station, the photoroentgenogram of a sailor presented some suggestive markings in the left apex. A routine anterior roentgenogram of the chest (Fig. 3) revealed some densities obscured by the ribs and clavicle.

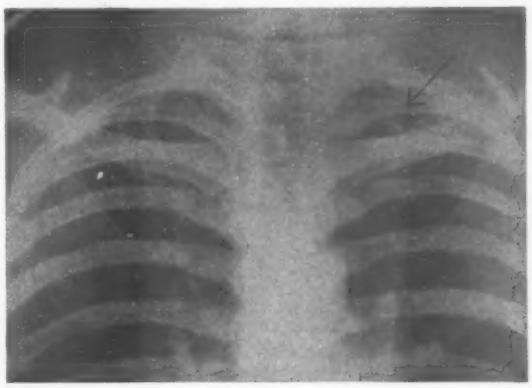

Fig. 4. Case II.

A roentgenogram was then taken in accordance with procedure 2 above (Fig. 4). This presented a round, dense, well-circumscribed nodule—a tuberculous focus. It was felt, however, that there was still some obscuration of the lesion, so a posterior lordotic view was made (Fig. 5). Arrow 1 points to the dense, well-rounded tuberculous focus seen previously in Figure 4. In addition, arrow 2 points to a softer, "fluffier" area of infiltration. Comparing the appearance of the tuberculous focus in Figures 4 and 5, it is noted that there is neither exaggeration nor distortion of the focus in the lordotic view, as modified. The focus in Figure 5 is, however, "softer" in appearance; and this is true of all the lung infiltrations and markings in the lordotic view.

IV. The lordotic view is of additional value as regards the problem of apical caps. The presence of such a cap *per se* is not considered as sufficient for rejection of an inductee. Nevertheless, it is known that of a group of men with apical caps exposed to identical environmental conditions (climate, food, shelter, work), some develop

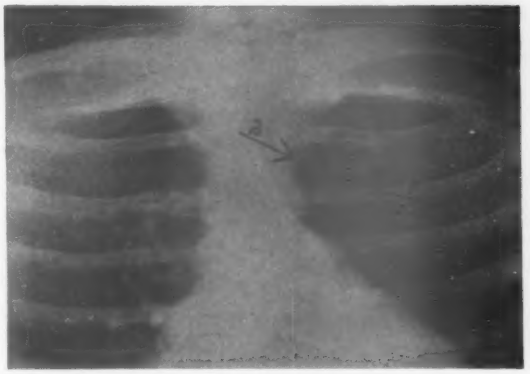

Fig. 5. Case II.

active apical tuberculosis, others do not. It is felt here, that this apparent selection may be due to the fact that some apical caps are associated with an underlying parenchymatous pathologic condition which they conceal in the routine anterior roentgenogram of the chest. Because of its clear portrayal of the upper limit of the parenchyma, the posterior lordotic view is used routinely in investigating apical caps.

In the absence of a cap and of underlying pathology, the lordotic view shows that the parenchyma has a sharp upper border and that the vessels extending from the upper pole of the hilar region end sharply ½ inch below this border (Fig. 5, right apex). If an apical cap alone is present, it appears as a membranous veil continuous above with the parenchymal boundary and terminating below in an irregular border which is usually joined by the vascular tree. This

Fig. 6. Case III.

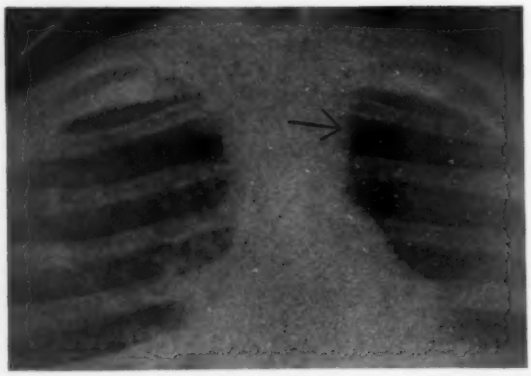

Fig. 7. Case III.

latter appearance is not considered as sufficient for rejection of an inductee. Where, in addition to this membranous veil, infiltrations or variously contoured hollow forms (not seen in the routine anterior chest) are present at the terminations of the vascular tree, it is considered that the inductee is not a good risk.[3]

Case III. Figure 6 is a routine anterior chest with a left apical cap. Opinion was divided as to acceptance of the inductee. The posterior lordotic view (Fig. 7) shows numerous infiltrations and hollow forms (the arrow points to one which may be a cavity) and leaves no doubt that the individual should be rejected.

Case IV. Figure 8 is a routine anterior chest with a very dense and irregular left apical cap. Opinion was divided as to acceptance of the inductee. The posterior lordotic view (Fig. 9) shows the cap as a membranous veil whose lower border is joined by vessels from the upper pole of the hilar region. There are, however, no infiltrations nor hollow forms and the inductee is considered a good risk.

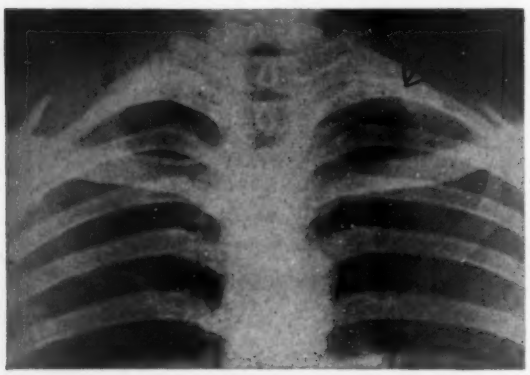

Fig. 8. Case IV.

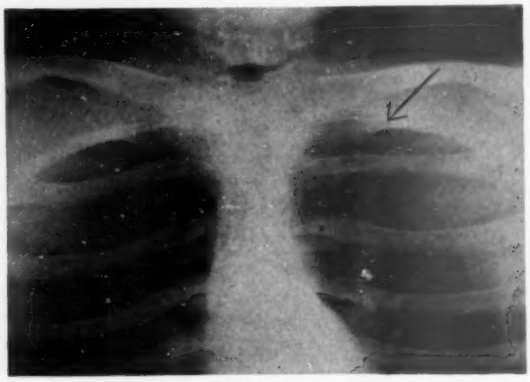

Fig. 9. Case IV.

SUMMARY

Experience has shown that the posterior lordotic position, with modification, is exceptionally well suited to the study of the apical regions. Technically, however, the procedure is arduous and time consuming to carry out with constant good results. In an induction station processing hundreds of men a day, time is of the essence. The use of the lordotic position in such an installation is therefore suggested only for those cases in which apical findings in the photoroentgenogram are obscured by ribs or clavicle, or for those cases presenting apical caps. Where the finding is not obscured in the photoroentgenogram, the anterior chest roentgenogram modified in accordance with procedure 1 or 2 is the simplest and best applicable.

1364 42nd St.
Brooklyn, N. Y.

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HEAT CAPACITIES OF ROENTGEN-RAY TUBES

WITH PARTICULAR REFERENCE TO USE FOR MASS SURVEY WORK

By Z. J. ATLEE *and* C. H. MORRIS

Vacuum Tube Engineering Department, General Electric X-Ray Corporation

CHICAGO, ILLINOIS

THE heat capacity of diagnostic roentgen-ray tubes, particularly of the oil immersed shock-proof casing type, has been the subject of much consideration within recent years. This has been due in part to the great amount of mass survey chest examination done mostly with photoroentgenographic equipment by the Armed Forces and public health groups during the war. Such a type of examination will continue to increase, and the problem of hourly or daily capacities of the tube and casing will always be important. Therefore, it is felt desirable to point out some of the factors involved and to make some recommendations to help in obtaining satisfactory tube performance.

More roentgen tubes have been destroyed in mass survey examination by an overload in total heat input than by any other cause. There are many factors entering into this situation, but probably the main fault has been the attempt to crowd too much heat loading into a given interval, or as we shall refer to it, the "per minute" rate used has been too high. In addition, of course, there have been plenty of cases in which the total heat input "per hour" loading has been in excess of the heat capacity of the system. However, the advent of blowers for circulating a large quantity of air around the casing has generally prevented such failures. There are still too many installations doing mass survey work without any, or adequate, blowers on the casing.

Rotating anode tubes are now being used quite extensively for this type of examination so the factors involved in their use will also be discussed. It is certainly reasonable to predict that in the future an even larger number of this type of tube will be used for this work, and the performance that is now being obtained will have much to do with the final proportion. It is hoped that by pointing out some of the inherent limitations in such tubes, better performance can be realized.

In the case of the stationary anode tube, a massive copper anode connects directly with the oil in the casing. The cross section of the anode shank in contact with the oil is limited, so that for the heavy duty work under consideration, there is a danger of overheating the anode adjacent to the tungsten. A copper melt at the upper part of the anode face immediately suggests too high a per minute loading. The heat storage capacity is necessarily limited, and when the tube is operated more or less continuously there is little reserve capacity available. In the usual clinics or hospitals doing routine roentgenography, the tube and housing are not normally loaded to anywhere near peak capacity so that instantaneous overloads are permissible. In other words, the heat capacity reservoir has sufficient space for these extra exposures. Mass survey examination means usually several exposures per minute continuously for several hours at a time so that there is no extra heat storage available. Therefore, the problem is to provide sufficient capacity in the overall system of tube and casing to give satisfactory performance.

NEW TYPE SYSTEM CAPACITY CURVE

Anode cooling curves in themselves are meaningless for such work. The only important figure that can be obtained from them is the heat storage for governing an initial single exposure. These curves are of no value for individual exposures when an hour's performance has heated all the parts to near the maximum. The necessary cool-

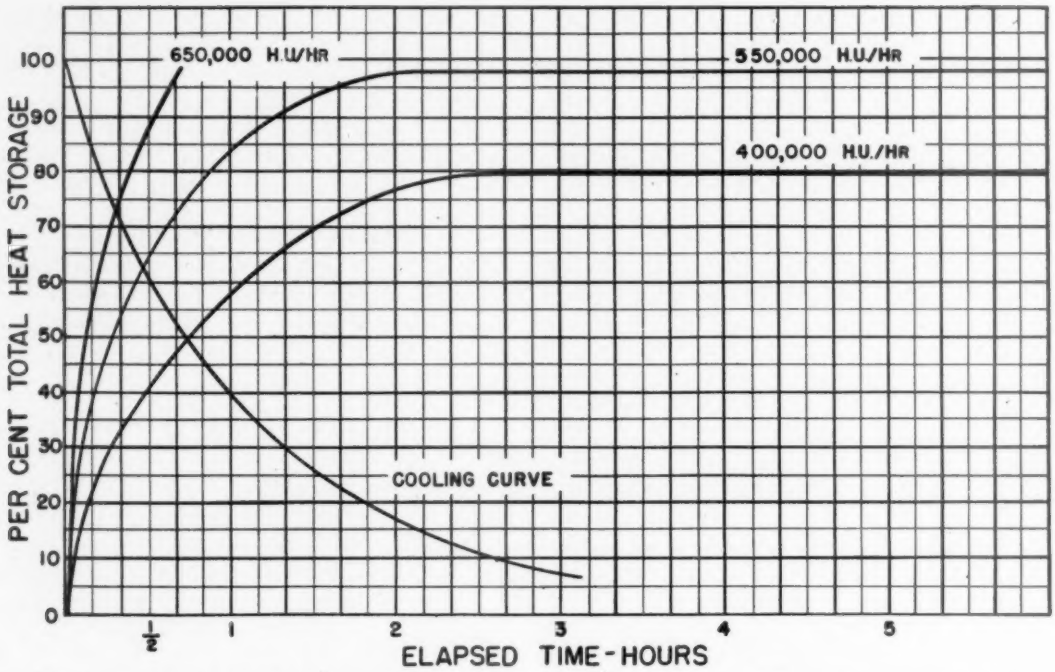

FIG. 1. Stationary anode tube casing heat capacity without blower; 20° C. ambient temperature.

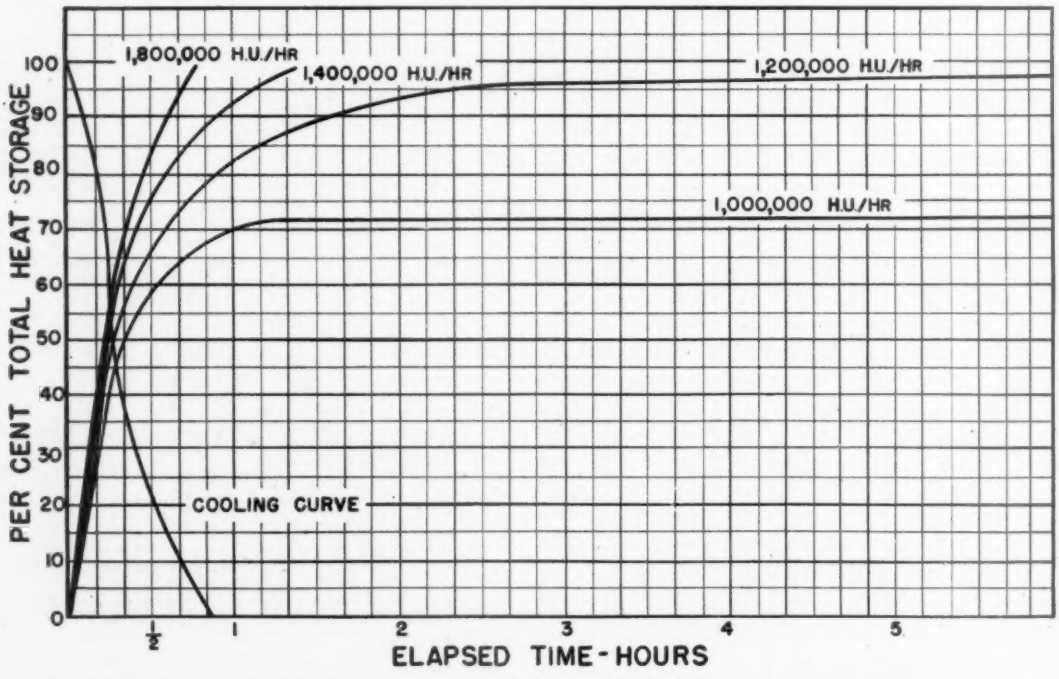

FIG. 2. Stationary anode tube casing heat capacity with single blower; 20° C. ambient temperature.

ing curve and heat loading is that for the entire system of tube and casing. Figure 1 illustrates the type of graph which seems more adequately and correctly to express the heat capacity of the system. This graph is for a stationary anode tube and casing without a blower and the per minute rate can be obtained by division. For 550,000

heat units per hour (kv.p. ×ma. ×sec.) the per minute rate is only 9,166 which is not adequate for any but the very lightest mass survey work. The per minute capacity for photoroentgenography using a single emulsion film and a grid for stereo pairs and as many as two or even four per minute involves a per minute rate of heat units up to 20,000.

Such a capacity can be obtained from the same tube and housing by the addition of an air circulating blower attached to the housing as shown in Figure 2. This will give at least 1,200,000 heat units per hour or 20,000 heat units per minute. Two blowers of this type can raise the capacity to 1,500,000 heat units per hour or 25,000 per minute. Above this figure, the tube capacity seems to be the limiting condition, but a somewhat more massive anode may bring the capacity to 1,800,000 heat units per hour or 30,000 per minute. This hourly figure may never be needed, but this per minute rate may add some additional factor of safety where the tendency to crowd exposures too closely together may occur. Figure 3 shows a loading capacity curve of the casing and tube with a double blower.

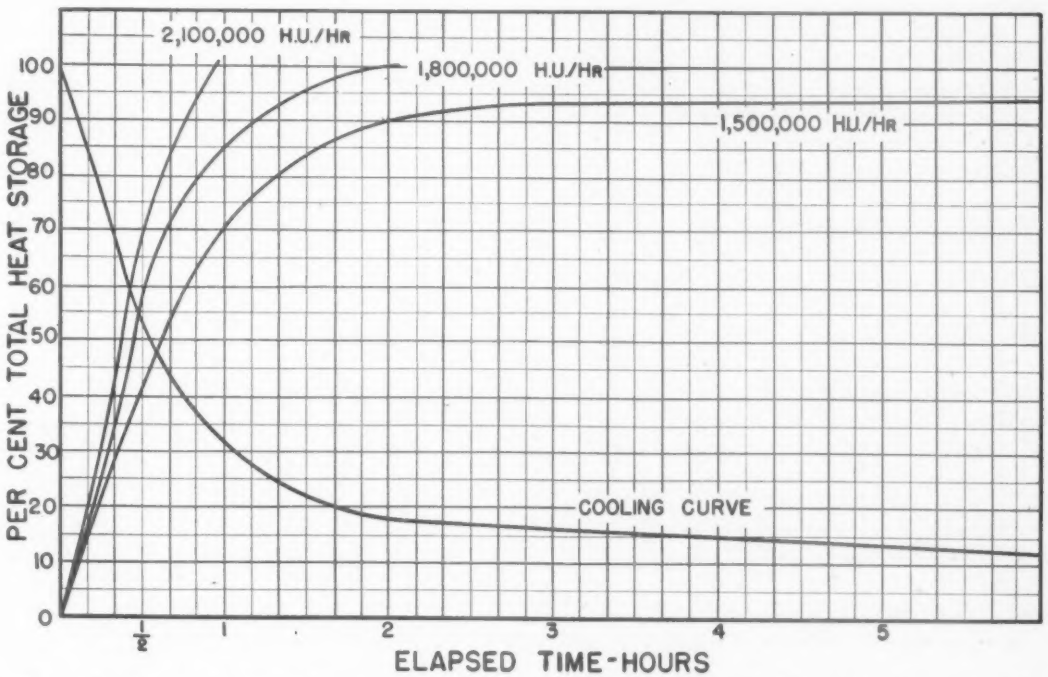

Fig. 3. Stationary anode tube casing heat capacity with double blower; 20° C. ambient temperature.

ROTATING ANODE SYSTEM CAPACITIES

Rotating anode tubes do not have direct conduction of heat to the oil because the bearings upon which the anode revolves give complete thermal insulation. Therefore, all of the heat must be dissipated by radiation and the problem is considerably more complex than for a stationary anode type of tube. Anode heat storage curves are even more meaningless and the only proper way that the true heat capacity can be expressed is in the fashion shown.

Two types of rotating anode tubes are in use so that both must be considered when discussing their capacities. The solid tungsten disk type operates at a high temperature and has a limited mass. The solid copper anode with an imbedded tungsten path operates at a lower temperature but has a much greater mass and greater radiating area with an emissivity factor

approaching a black body. It is somewhat surprising that the continuous capacity for mass survey examination is about the same for both types of construction. It can be shown theoretically with certain premises that the solid tungsten disk has greater capacity than the solid copper type. However, for actual use, other than possibly roentgenoscopy, the anode is not always at little regard to tube capacity. The solid disk tube, on the other hand, is limited because of its low heat storage and the result of individual exposures must be evaluated.

Figure 4 shows the heat capacity of the copper anode rotating anode tube casing without a blower. Figure 5 is for the same tube and casing with a blower system

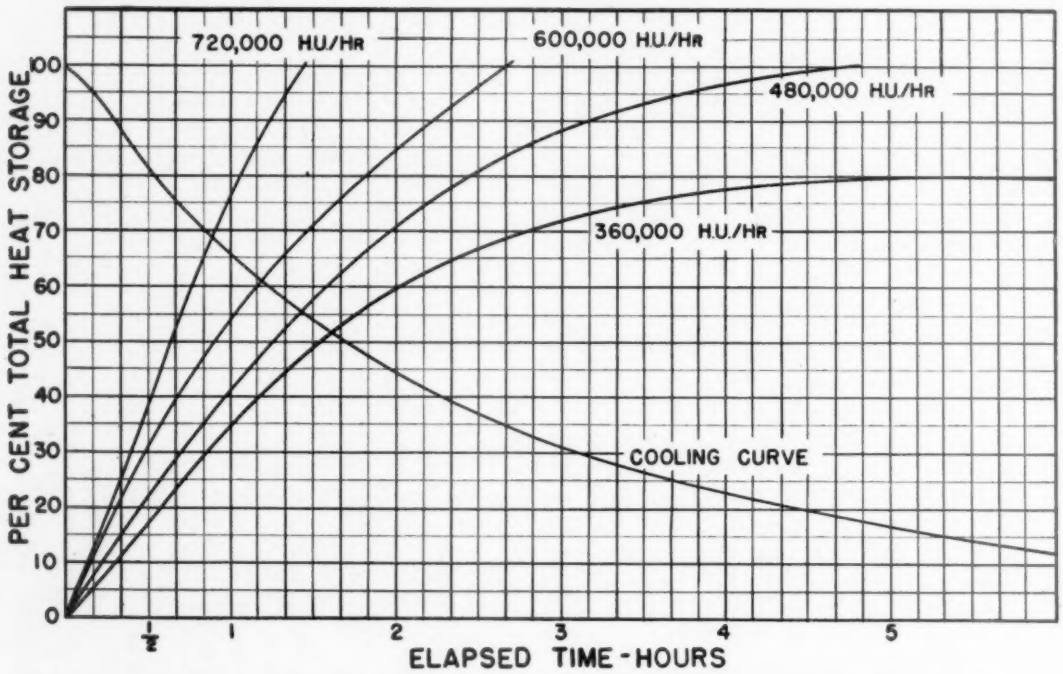

Fig. 4. Rotating anode tube casing heat capacity without blower; 20° C. ambient temperature.

maximum temperature as has been assumed. Even for photoroentgen work where the rate of heat input approaches more closely the continuously loaded condition, the anode is very seldom at its maximum temperature. Therefore, the value of heat radiation is some average value appreciably below the maximum. On the other hand, in the case of the copper anode with greater mass, the cooling is at a slower rate, but it is going on more efficiently between exposures.

For other than mass survey work the copper anode type of tube has a big advantage. Its great heat storage capacity allows complete freedom of technique with added. Similar curves could be given for the solid tungsten disk tube. For photo roentgenographic technique, the capacity with adequate blowers would be approximately 1,000,000 heat units per hour. For the variable technique of clinical roentgenography it would be considerably less.

These heat capacities are all given for an ambient room temperature of 20° C. which is probably the average value encountered. Higher ambients of 30° and even 40° C. are encountered and reduced capacities will result. It is expected that the manufacturer will supply the same type of graph herein presented possibly for the three different ambients 20, 30, and 40° C.

OTHER CONSIDERATIONS IN USE OF TUBES FOR SURVEY WORK

One factor that must be considered in computation of the rate of heat input in a rotating anode tube unit is the time the rotor is operated. If turned on continuously, the stator alone will account for the production of 1.8 million heat units in the casing. The curves shown for this type of tube unit are based upon the stator being energized for not more than 20 per cent of the time. This seems reasonable when the time required to change the film, position the patient, and give the patient instructions, are considered.

In the present design of rotating anode tubes using lubricated bearings, failure of the anode to rotate because of bearing failure is practically unknown. For mass survey work as well as others, it is advisable, however, to have the axis of the tube horizontal to distribute the weight of the anode equally on the two bearing assemblies.

Filament life is an important factor in both stationary and rotating anode tube life. Evaporation of the tungsten filament takes place as long as the filament is energized, and the rate of evaporation varies logarithmically with the filament current and therefore the tube current. Figure 6 shows the relationship of these factors for the type of filament wire used in tubes designed for mass survey examination. It is evident that it is worth while to turn off the filament between exposures and it is particularly a dividend paying practice at higher values of tube current.

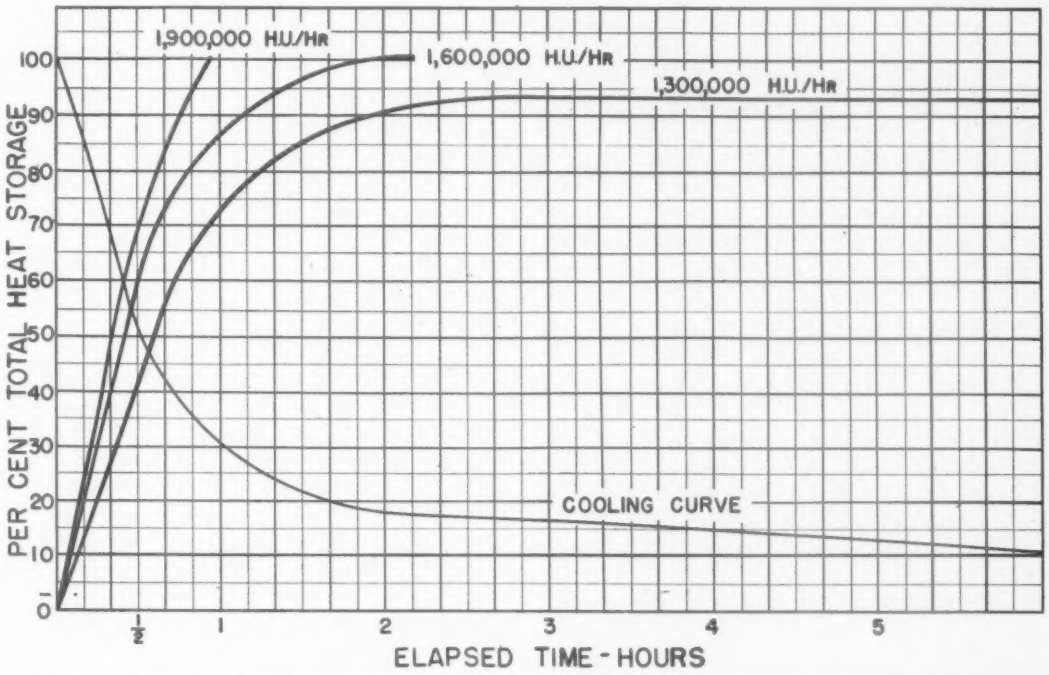

Fig. 5. Rotating anode tube casing heat capacity with double blower; 20° C. ambient temperature.

CONCLUSIONS

A new type of graph for presenting the overall system capacity of a shockproof tube housing combination is presented. With the value of total heat capacity that it is possible to obtain from such graphs, the amount of work that can be done with a given tube can be readily obtained. Selecting a technique the heat units per exposure can be obtained directly as those illustrated in Table 1.

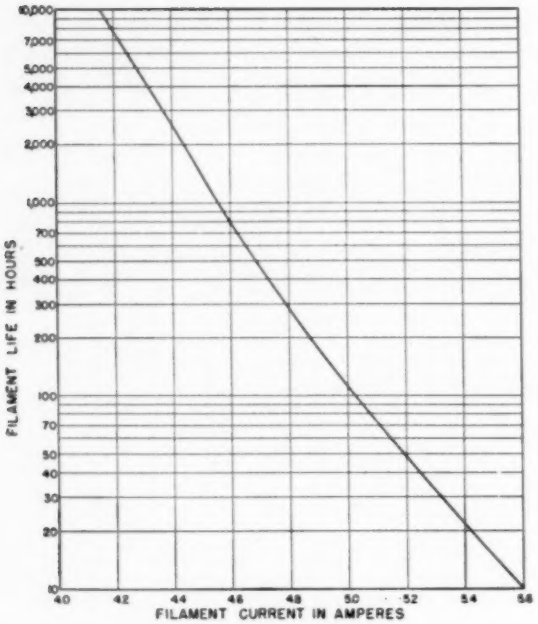

Fig. 6. Filament life values for diagnostic roentgen tubes; 0.0085 inch tungsten wire.

Table I

AVERAGE TECHNIQUE FACTORS FOR PHOTOROENTGENOGRAPHY SINGLE EMULSION FILM

Film Size	Focal-Film Distance	Grid Used	Kv. (peak)	Ma-sec.	Heat Units per Exposure
4×5 in.	40 in.	No	85	20	1,700
4×5 in.	40 in.	Yes	90	40	3,600
70 mm.	40 in.	No	80	20	1,600
70 mm.	40 in.	Yes	95	20	1,900

Knowing the heat units per exposure the amount of work expressed in exposures per hour or per minute are readily obtained from the chart in Figure 7. Using this chart it is possible to quickly determine whether the tube casing combination is adequate to do the volume of work required.

If the per minute and per hour rate of exposures indicated are not exceeded, improved tube performance will be realized.

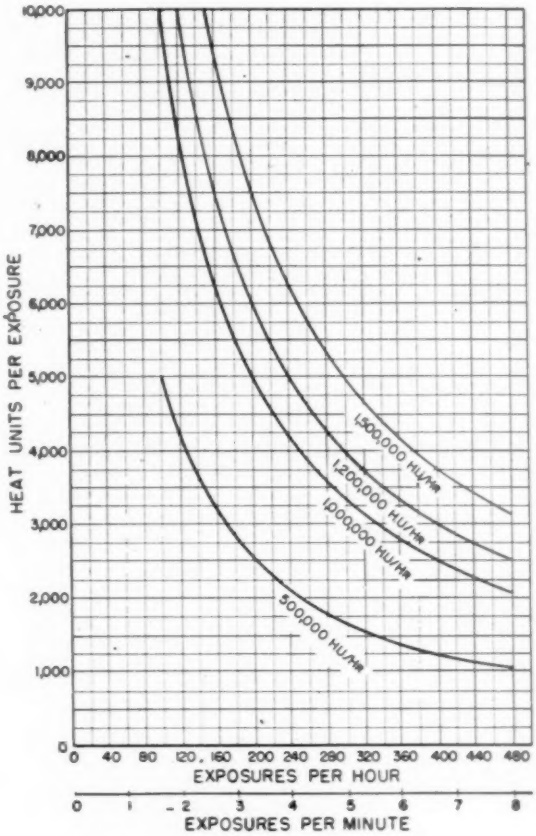

Fig. 7. Exposure rates for various casing capacities.

Also, if attention is paid to other details, such as length of filament burning, and rotation of a rotating tube is used, better performance will result.

General Electric X-Ray Corp.,
1417 W. Jackson Blvd.,
Chicago 7, Ill.

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Vol. 55, No. 5

AN ANALYSIS OF THE PHYSICAL FACTORS CONTROLLING THE DIAGNOSTIC QUALITY OF ROENTGEN IMAGES*

PART IV. CONTRAST AND THE FILM CONTRAST FACTOR

By RUSSELL H. MORGAN, M.D.

WASHINGTON, D. C.

IN THE preceding section of this series (Part III)† it was shown that the contrast exhibited by a roentgenographic image is governed by two principal factors: One, the intensity distribution function of the image, is related to the atomic composition of the structure under examination and to the properties of the roentgen beam with which the exposure is made. The second, the film contrast factor, is related to the characteristics of the roentgenographic film on which the image is recorded and to the process of developing. The first has been discussed in detail previously. In this communication attention will be directed to the second.

If a roentgenographic film is given a series of graded exposures and the resulting photographic densities are plotted as a function of the logarithm of the exposure, a curve similar to that illustrated in Figure 1 is produced. The slope of this curve is the film contrast factor, a parameter whose value clearly changes as one progresses from one density level to another.

The configuration exhibited by a film's density vs. log exposure curve is governed by a large number of factors including the characteristics of the film's photosensitive emulsion, the method of exposure (i.e., with intensifying screens, with direct roentgen radiation or by photofluorography), the quality of the exposing radiation, the exposure time and the process of development. The value of a film's contrast factor, therefore, is also influenced by these parameters.

† Am. J. Roentgenol. & Rad. Therapy, January, 1946, *55*, 67–89.

In Figure 2 are illustrated the density vs. log exposure curves of *a*, a roentgenographic film exposed with double intensifying screens; *b*, a roentgenographic film exposed

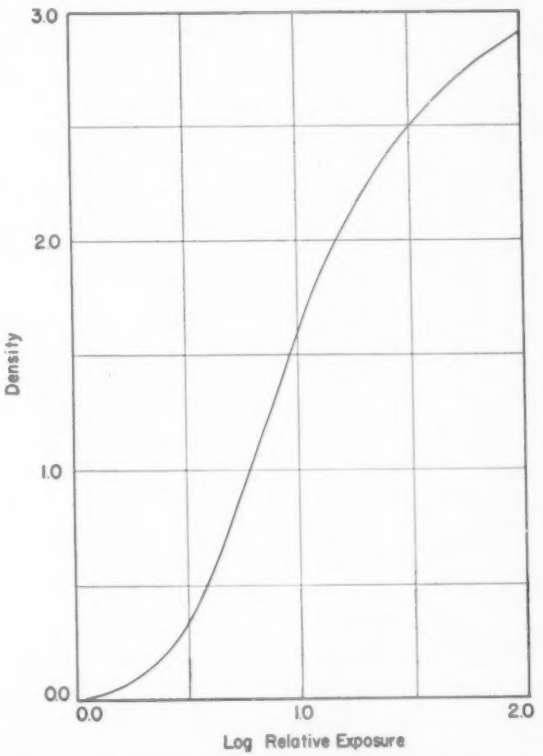

Fig. 1. Density of a typical roentgenographic film exposed with intensifying screens plotted as a function of the logarithm of the exposure received by the film.

to roentgen radiation directly and *c*, a photofluorographic film. It will be observed that curve *a* has a short toe and shoulder and a long, steep, intermediate inflection zone. Curve *b*, on the other hand, exhibits a long toe and shoulder and a

* From the Division of Roentgenology, The University of Chicago, and the Radiology Section, Tuberculosis Control Division, United States Public Health Service.

relatively short intermediate inflection zone. The photofluorographic curve, *c*, presents many of the features of curve *a* but its slope at corresponding density levels is appreciably less.

Values of the contrast factors of the three films whose characteristics are shown in Figure 2 are plotted as a function of film density in Figure 3. These values were determined merely by measuring the slopes of the several density vs. log exposure curves at a number of density levels. It may be seen that the value of the contrast factor of the film exposed with double intensifying screens (curve *a*) rises sharply with increasing density, undergoes a small sigmoid inflection, reaches a maximum, passes through another, but more pronounced, sigmoid inflection and then descends gradually to zero at high density levels. The contrast factor of the film exposed to roentgen rays directly (curve *b*) rises relatively slowly with increasing density and approaches a maximum only after a comparatively high density level is reached. Indeed the values of this film's contrast factor are considerably less than those of films exposed with intensifying screens through a large portion of the density range. The configuration of curve *c*, representing the characteristics of the photofluorographic film is similar to that of curve *a* in many respects. The photofluorographic curve, however, is considerably lower than that of the roentgenographic film. Although Figure 3 presents but one example for each exposure condition, the data are typical of most roentgen emulsions available today.

The differences which exist between the several curves in Figures 2 and 3 may be ascribed to a number of factors. The rapid initial rise in the contrast factor vs. film density curves of the films which are exposed with fluorescent radiation (curves *a* and *c*, Fig. 3) is caused by the short toes which the density vs. log exposure curves of these films characteristically exhibit (curves *a* and *c*, Fig. 2). The reason why films exposed with fluorescent radiation should possess such a property and films exposed to direct roentgen radiation should not, may be found in the fact that films exposed with radiation falling within or near the visible spectrum require a certain minimum exposure before any significant photochemical effect is produced (i.e., these films exhibit inertia) whereas films exposed to roentgen radiation do not. This phenomenon is illustrated graphically in Figure 4 where the densities of a roentgenographic film exposed *a*, with intensifying screens

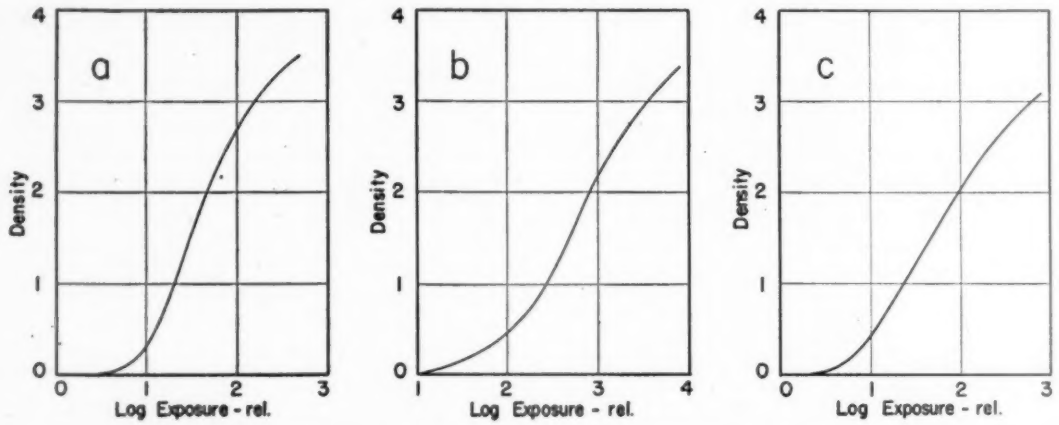

Fig. 2. Density vs. log exposure curves of three typical roentgenographic materials. *a*, film exposed with double intensifying screens; *b*, film exposed to roentgen radiation directly; and *c*, film exposed photofluorographically.

and *b*, without intensifying screens are plotted as a function of the exposure received by the films. It is evident that the density of the film exposed with intensifying screens remains essentially zero until after a certain minimum exposure has been exceeded. When the curves are plotted as a function of the logarithm of the exposure the inertia of the intensifying screen exposure manifests itself by producing a curve having a short toe. The cause of the inertia phenomenon in films exposed to visible light (intensifying screens) and its absence in films exposed to direct roentgen radiation has been recently speculated upon by the author.[1] It appears to be the result of marked differences in the photonic energy possessed by the two types of exposing radiation.

The two series of sigmoid inflections which occur in the contrast factor vs. film density curve of the roentgenographic film exposed with double intensifying screens are caused in part by the unusual light distribution that exists in the film's photosensitive emulsion when light enters it from two directions. The phenomenon is less marked when the same film is exposed with a single intensifying screen.

The bilateral exposure of the roentgenographic film exposed with double intensifying screens also explains why the contrast factor values of that film are appreciably greater than those of the photofluorographic film. Referring to Figure 5 where the quantities of radiation received at various positions in the photosensitive emulsion of *a*, a photofluorographic film and *b*, a roentgenographic film exposed with double intensifying screens are plotted graphically, it is evident that a large portion of the radiation is absorbed in the surface layers of the emulsion in each case. However, in the roentgenographic exposure the distribution of the total radiation received from the two screens is such that the deeper layers of the emulsion are almost as well exposed as the surface layers. Accordingly, the "effective" thickness of the

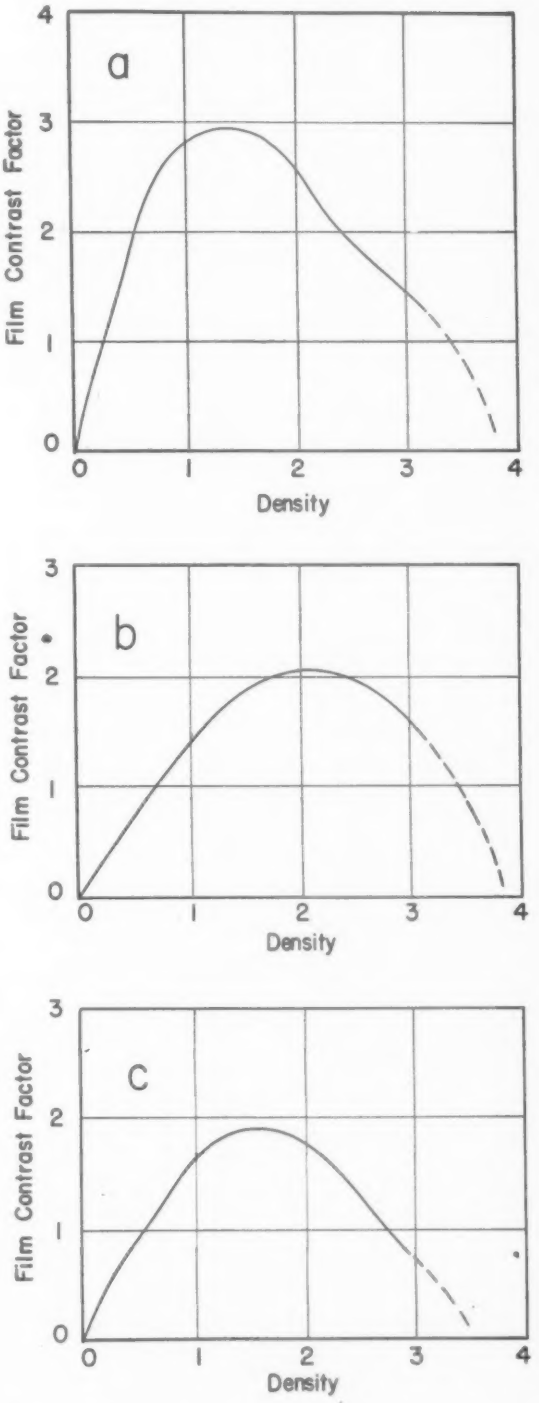

Fig. 3. Film contrast factor vs. density curves of three typical roentgenographic materials. *a*, film exposed with double intensifying screens; *b*, film exposed to roentgen radiation directly; and *c*, film exposed photofluorographically.

roentgenographic emulsion is considerably greater than that of the photofluorographic emulsion, a situation which promotes, in the former instance, the deposition of larger quantities of silver per unit change in exposure, and thereby a higher contrast factor value. That this explanation is reasonably correct is supported by the changes occurring in the relative brilliance of the two screens under various conditions of exposure as no changes are observed when exposures are made with single intensifying screens, with direct roentgen radiation or by photofluorography.

Figure 6 illustrates three contrast factor vs. film density curves of a typical roent-

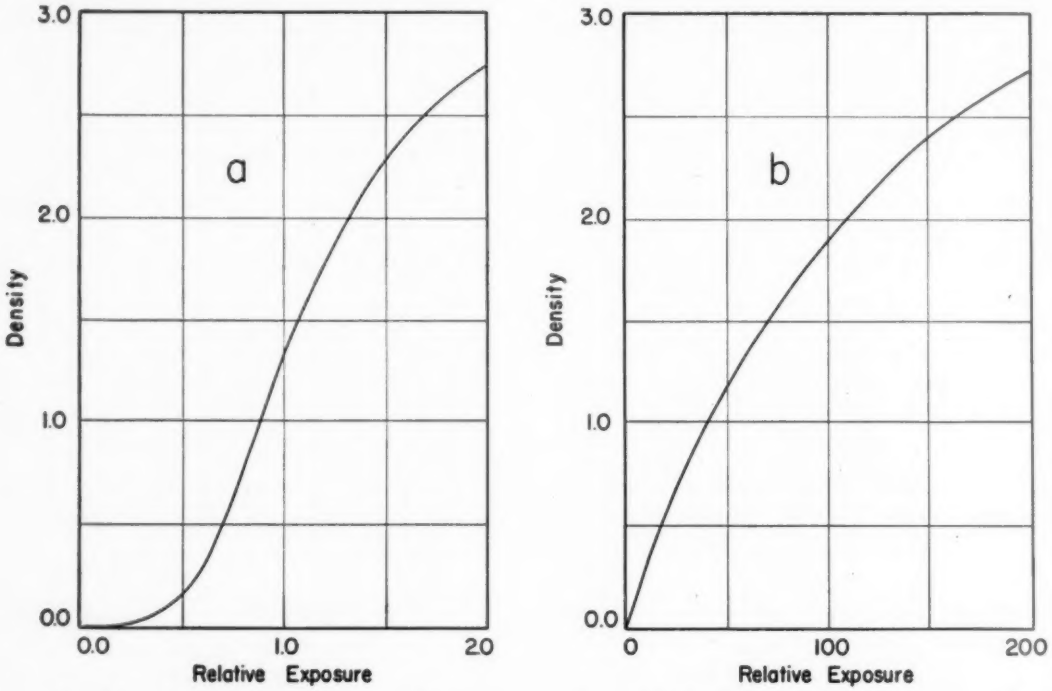

FIG. 4. Densities of a typical roentgenographic film exposed: *a*, with double intensifying screens and *b*, without intensifying screens plotted as a function of the exposure received by the films. Observe that the density of the film exposed with intensifying screens remains essentially zero until after a certain minimum exposure has been exceeded.

experimental observation that the contrast factor values of roentgenographic films exposed with single intensifying screens (unilateral exposure) are similar to those of photofluorographic films.

The contrast factor of a film is dependent, under some circumstances, on the quality of the exposing radiation. When exposures are made with double intensifying screens small changes in the configuration of the contrast factor vs. film density curve may be observed when the spectral distribution of the roentgen radiation is altered. This effect seems to be related to genographic film exposed with double intensifying screens; the half-value layers of the exciting roentgen radiation were 0.5 mm. Al, 2.0 mm. Al and 8.0 mm. Al. It will be observed that changes in the quality of the exposing radiation produce only minor changes in the value of the film contrast factor. Similarly, small changes are observed in other film-screen combinations. Film-screen combinations in which the back screen is thicker than the front tend to exhibit a decrease in their film contrast factor values when the half-value layer of the exposing radiation increases. Combina-

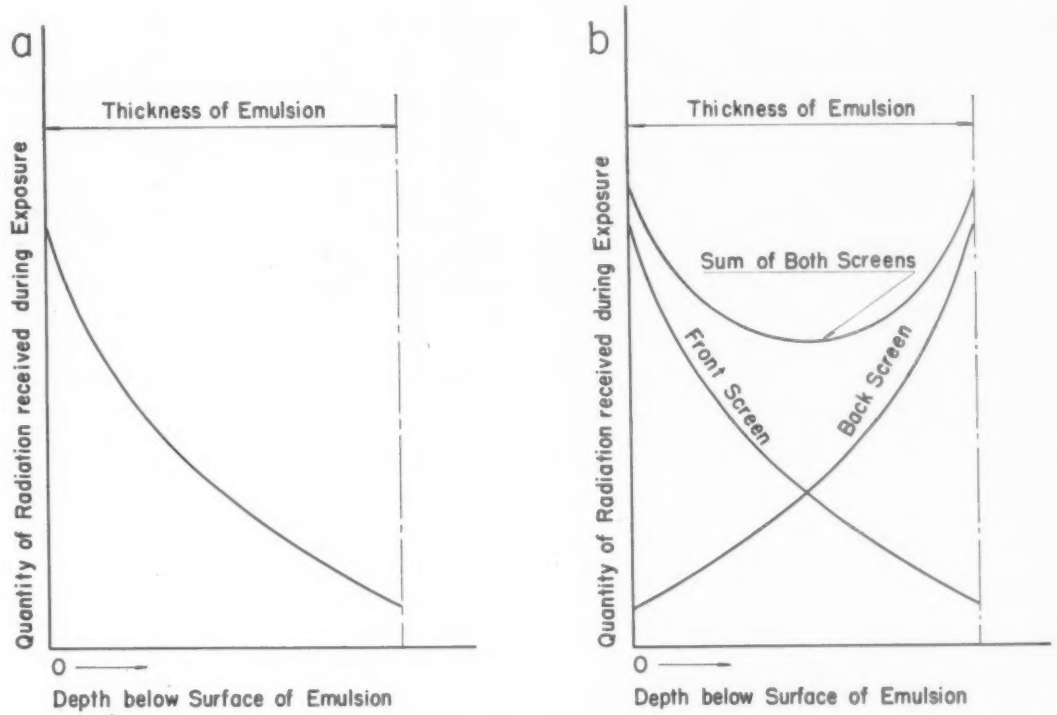

Fig. 5. Quantities of radiation received at various positions below the surface of the photosensitive emulsion of: *a*, a photofluorographic film and *b*, a roentgenographic film exposed with double intensifying screens. Observe how the latter emulsion is well exposed even in the deeper layers.

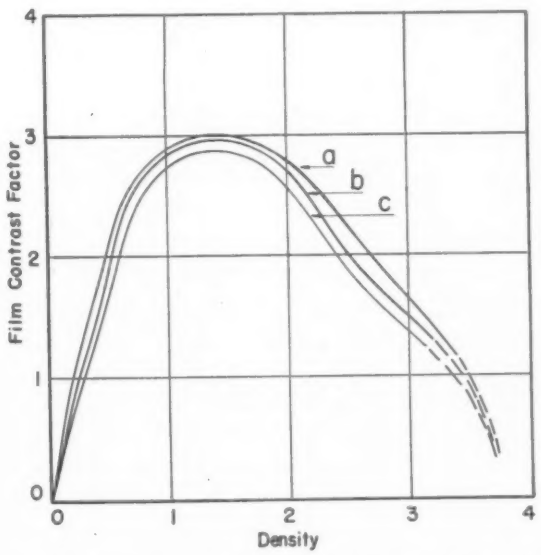

Fig. 6. Film contrast factor vs. density curves of a typical roentgenographic film exposed with double intensifying screens at: *a*, a half-value layer of 0.5 mm. Al; *b*, a half-value layer of 2.0 mm. Al; and *c*, a half-value layer of 8.0 mm. Al.

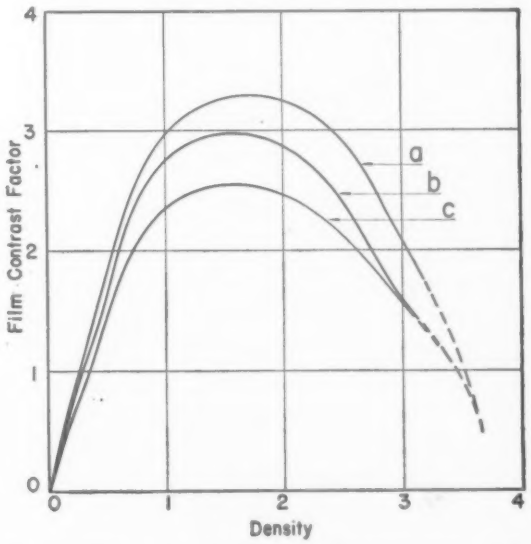

Fig. 7. Film contrast factor vs. density curves of a typical roentgenographic film exposed with double intensifying screens at exposure times of: *a*, 10 seconds; *b*, 1.0 second; and *c*, 0.1 second. The changes observed are limited to films exposed with fluorescent radiation; they are more marked in some brands of film than in others.

tions in which the two screens are similar tend to behave in the opposite manner.

The configurations of the contrast factor vs. film density curves of films exposed with fluorescent radiation are influenced by the exposure time with which the films are made. This is well shown in Figure 7 where the curves of a typical roentgeno-

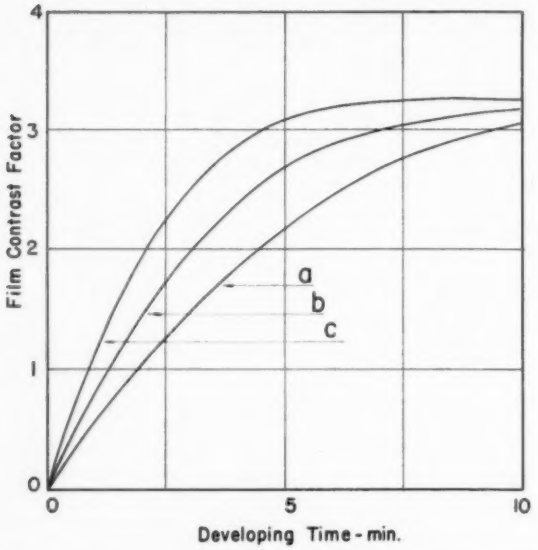

FIG. 8. Film contrast factor values of a typical roentgenographic film, exposed with intensifying screens and measured at a film density of 1.0, plotted as a function of developing time. Developer temperature: *a*, 62° F.: *b*, 65° F.; and *c*, 68° F.

graphic film exposed with double intensifying screens at exposure times of 10 seconds, 1.0 second and 0.1 second are illustrated. The phenomenon is due to the fact that films when exposed with radiation within or near the visible spectrum require different quantities of radiation to produce a given photochemical effect at various intensity levels.[1] The configurations of the contrast factor vs. film density curves of films which do not exhibit this property (films exposed to roentgen rays directly) are unaffected by changes in exposure time. It will be observed (Fig. 7) that the magnitude of the sigmoid inflection in the high density limb of the contrast factor vs. film density curves of films exposed with fluorescent radiation is governed to a marked degree by the exposure time with which the films are made.

The process of development exerts a profound influence over the contrast factor of a film. Indeed the dependence is so great that the maximum value of a film's contrast factor (i.e., the maximum slope of the density vs. log exposure curve) is usually referred to in the photographic literature[2] as the development factor. In Figure 8 are plotted the values of the contrast factor of a typical roentgenographic film exposed with double intensifying screens against the time of development at three temperature levels; the various values were measured at a film density of 1.0. The curves are of the exponential type in which the contrast factor values increase quickly in the early stages of development, then less rapidly until finally they approach a constant level.

The recommended developing time of the developer employed in the preparation of Figure 8 is 5 minutes at 65° F. This time is somewhat less than that required to obtain a maximum value of the film contrast factor and it may be argued, therefore, that the recommendation is incorrect. However, the density of a roentgenographic film increases as development progresses in much the same manner as the film contrast factor and accordingly if one permits the film to develop to the point where a maximum contrast factor value is established, developmental control of density will be lost. This would not be detrimental whatsoever if it were possible to maintain sufficient control of roentgenographic exposure so that the density of the completely developed film would always coincide with the density of optimum diagnostic quality. However, the commonly used tissue-thickness method of calculating exposure does not provide such control and it is therefore necessary to underdevelop all roentgenographic films routinely to provide a mechanism with which the effects of incorrectly exposed films may be compensated. By slight underdevelopment the density of a film is brought under the

control of the developmental process although at some expense to the value of the film contrast factor. Minor errors in exposure may then be corrected by giving shorter or longer development as required to bring the film into the optimal density range. This system is open to considerable criticism because of difficulty in judging the quality of a film under the conditions of illumination existing in the roentgenographic darkroom. It is hoped that the automatic control of roentgenographic exposure by photoelectric methods will eliminate the need for this technique. Theoretically such control should permit full film development and yet produce roentgenograms of consistently high quality.

Of the several factors which control the value of a film's contrast factor it is evident from the foregoing that developing parameters and film density are the most important. The low contrast factor values obtained with inadequate development and the resulting low resolving power exhibited by the finished film clearly indicate the inadvisability of underdeveloping roentgenographic films. Of equal importance is the need for exposing the film properly so that the significant images will possess a density which will yield a high level of contrast. If both of these factors are constantly borne in mind the attainment of optimum diagnostic quality in roentgenograms will be greatly facilitated.

Tuberculosis Control Division
U. S. Public Health Service
Washington 14, D. C.

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A RECENT VISIT WITH FRENCH RADIOLOGISTS

By WILLIAM M. LOEHR, M.D.
INDIANAPOLIS, INDIANA

The profession is in truth a sort of guild or brotherhood, any member of which can take up his calling in any part of the world and find brethren whose language and methods and whose aims and ways are identical with his own.

—Sir William Osler

DURING the recent war it was necessary for the writer to "take up his calling" as radiologist with a general hospital which was stationed at Rouen and some nine months and thousands of patients later at Paris, France. This European service, all of it confined to France, furnished an excellent opportunity to meet and become acquainted with our French colleagues. Since many of the readers of the Journal have not (in all probability) had an opportunity to see or communicate with their radiological friends in that country during the war years, this communication is furnished more or less in the nature of a news report, illustrated within the limitations imposed by a mediocre, small camera and the somewhat erratic supply of photographic film available at the time of the visits and interviews.

The sojourn began in late November, 1944, when our hospital took over the duties of the 6th (Br) General Hospital, British Liberation Army, at Rouen, France. I was greatly impressed by the unusual coincidence of doing the same job, in the very same city, even to taking over the duties of an evacuated British General Hospital, that was done just twenty-seven years previously by Dr. Edwin C. Ernst[1] of the then St. Louis Base Hospital No. 21. Especially was this coincidence uppermost in mind since I had heard Dr. Ernst's paper and seen his very excellent exhibit presented at the Twenty-sixth Annual Meeting of the Radiological Society of North America at Cleveland, Ohio, in December, 1940. The "laws" of chance and probability and the strange vagaries of military assignment took me to both his exhibit and paper and again over his same footsteps on foreign assignment, with, however, the marvelous advantages at the hand of young radiologists today in the form of truly rugged and dependable equipment and roentgenological apparatus. How remarkably easy and free from trouble was our work from the technical standpoint in this war! Our hospital facilities and buildings were considerably more pleasant and agreeable than Dr. Ernst's tents and wooden huts of twenty-seven years ago. The terrific air bombardment sustained by the very important port city of Rouen somehow spared the historic XVIIth century Hôtel Dieu, the principal teaching hospital of the Faculty of Medicine of Rouen. We moved into very spacious quarters previously occupied by the Germans and the British but were compelled to use U. S. Army Field Unit equipment because of the effective and complete German destruction of a quite modern Massiot stationary unit and a splendid Phillips rotating-anode apparatus, which neither British nor American equipment-maintenance personnel were able to repair.

It was possible during the stay of nine months in Rouen to explore its corners and enjoy the historical treasures that the centuries had here accumulated for the taking. Here were seen the home of Pierre Corneille, the great French dramatist (1606–1684). In one corner of the ground floor of our hospital the nuns of the Hôtel Dieu faithfully and carefully guarded many treasures of French medicine, notably a thesis of Laennec written in his own hand, Directly above this small museum were the rooms in which was born one of the most famous French authors of romantic fiction, Gustave Flaubert (1821–1880) whose "Madame Bovary" nearly all of us have read. He was the son of Achille Flaubert, chief

[1] Ernst, E. C. Reminiscences of roentgenology during the last war 1917–1919. *Radiology*, 1941, *36*, 421–434.

surgeon of the Hôtel Dieu, who had his home in these rooms. Rouen is also the native city of Guy de Maupassant (1850–1893), the painter, Gericault (1791–1824), the explorer of America, Cavalier de la Salle (1640–1786). The late great bacteriologist and scholar, Charles Nicolle, winner of the Nobel Prize in Medicine in 1928, was born in Rouen and taught bacteriology at the medical school there before becoming director of the Pasteur Institute at Tunis. An excellent bust of this savant stood in the Pathology and Clinical Laboratory Department of our hospital. The Place du Vieux-Marché is the square in which Jeanne d'Arc was burned at the stake in 1431 and was but two blocks from the hospital. Rouen may well be called the Museum City, with its many picturesque streets, old XVth and XVIth century wooden houses, its beautiful Gothic churches—many damaged but not irreparably—its attractive situation by the winding river Seine, and the beauty of the lush, rolling Normandy farm land surrounding it, make it "the finest town in France"—at least, so said the well known contemporary author, André Maurois (b. 1885–), born at Elbeuf, twelve miles south of Rouen.

The first radiological colleague to befriend me by offering me the use of his splendid library was Dr. Maurice Lessertisseur. I am certain reference books are items the itinerant Army roentgenologist misses most, for he cannot burden down his personal luggage with the heavy standard works. During peace-time Dr. Lessertisseur was chef de service d'électrologie at the Hôtel Dieu. It was his hospital office and laboratory we were occupying, the Doctor continuing to maintain his private practice at 48 rue Thiers. I had occasion to visit his office many times and was always impressed with the fine equipment he possessed. Particularly, complete and splendid was the large Massiot roentgenographic apparatus he used for gastrointestinal work. Purchased eight years before the war (making it twelve years old when I saw it), it was equipped for mucosal relief technique and compression film work as are few units in America today. His gastrointestinal roentgenograms were beautiful and clearly demonstrated how much longer the radiologist doing general radiologic practice in a French province has been using a superior method and type of equipment only just now coming into wider use in the United States. My visits with Dr. Lessertisseur also impressed upon me for the first time the wide scope of the word "électroradiologiste." In France the radiologist employs the roentgen ray and radium in the diagnosis and treatment of disease *and* all other forms of radiant energy, heat, diathermy, nerve-muscle stimulations and all the armamentarium of the American specialist in physical medicine. I mention this for the younger readers of this article, who, like myself, I feel certain, do not fully appreciate this fact. The older men, of course, who have visited abroad, know this. The radiologist in France, and in Europe generally, has a much longer course of study, involving training in the skillful use of many more agents than roentgen rays and radium. The chief shortages of my friend in Rouen during the stay there were films, hangers and developing chemicals. You can imagine the despair which attended the processing of what films he could obtain in chemicals many weeks old and past their usefulness.

While in Rouen many interesting discussions were had with Professor Felix Dévé. Dr. Dévé is head of the department of medicine at the medical school and whereever echinococcus or hydatid disease is encountered his name is quoted as a world authority. He has devoted forty-five years to the study of this disease and contributed 318 publications to the literature on this subject alone. On the evening of June 19, 1945, he addressed the staff meeting of our general hospital on his forty-five years of study of this disease and discussed in particular echinococcus disease in the United States and Canada. He had a gigantic and interesting collection of pathological speci-

mens of hydatid disease, specimens of the disease in man and a great many from his numerous experiments with animals. Many of his papers cover the purely roentgenological aspects of this disease and certain others consider roentgen therapy in experimental animals (with entirely negative results). Practically all his reprints were destroyed when his home was gutted during an air-raid, and I appreciated all the more those reprints he so kindly gave me.

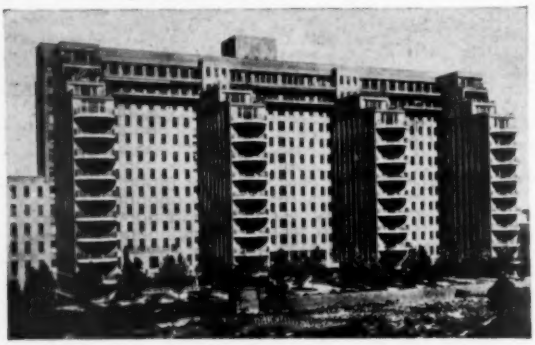

Fig. 1. Hôpital Beaujon, Paris.

This wonderful teacher and clinician seems almost fanatically devoted to medicine and science and impressed me as one who would demand of his students and interns the same exclusive concentration on the study of disease which had governed his own life.

The assignment of our hospital to Paris in early September, 1945, made it possible to become acquainted with the principal radiologists of Paris. We followed the Loyola University (Chicago) Medical School Unit (Alfred C. Ledoux, radiologist) into the beautiful Hôpital Beaujon (Fig. 1). This beautiful modern hospital was constructed by the French between 1930 and 1935 and rivals anything in America in hospital architecture and design. During the war the hospital was taken over by the Germans on June 19, 1940, at the fall of Paris. With the coming of the Americans and the uprising of the Free French, the Germans evacuated all their patients, even the dying, by noon, August 19, 1944. The American entry came with the advance party of the Loyola Unit on August 28, 1944. This organization operated the plant until midnight of September 12, 1945, when our unit (the 179th General Hospital) took it over. We closed the plant as a military hospital and returned it to the French in early November.

The first opportunity that presented itself was a visit to the Curie Hospital and the Institut du Radium. Dr. A. Lacassagne is the Director of the Institute, Sections of Biology and Therapeutics. He was most cordial, showing me through his laboratories and making arrangements to view the clinical radium work under Mlle. Baud, a most skillful worker and long a member of the staff. It was interesting to note that the standardization of therapy with radium generally agreed upon throughout the world made the cases seen at the Curie Hospital no different as to clinical handling, dosage, method and site of application, from those at home. Other members who were most kind and liberal with their time were Jacques Lavedan, chef de laboratoire, Fondation Curie, who has just published a most clear and concise small book,

Fig. 2. Curie Hospital, Paris.

"L'action des radiations sur la cellule normale,"* and Dr. F. Baclesse in charge of roentgen therapy at the Curie Hospital.

The hospital (Fig. 2) suffered no physical damage during the war but shared the same shortage in medical supplies, cotton, dressings, antiseptics, drugs, etc., that all

* Gauthier-Villars, Editeur, 55 Quai des Grands-Augustins, Paris 6, 1945.

France suffered. And, of course, the excellent library received no journals or books. No American physician can truly appreciate what it means to be cut off entirely from the major journals and publications. If you could have seen with what joy and happiness Dr. Lacassagne received the six copies of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY—my own personal copies received through the military mail and the first they had received in nearly five years—you could perhaps appreciate a little what medieval darkness had covered their library during the occupation.

The original laboratory of Pierre and Marie Curie, where the discovery and isolation of radium was accomplished, is not to be found. A large, modern industrial chemical factory sprawls over the ground where the Curies worked and only a small bronze tablet high on one of the walls of the factory indicates what position the shed and laboratory would occupy if they were still standing. The most treasured items of laboratory apparatus and equipment which would make a museum are in the possession of Mme. Joliot-Curie and her husband. It was a genuine disappointment not to be able to see a museum for Pierre and Marie Curie comparable to that of Röntgen's at Würzburg. In a visit with Mme. Joliot-Curie on October 17, 1945, she said that one day this might be done. It was a very exciting privilege to be able to meet and speak with this great physicist (Fig. 3). Through the assistance of two friends, one of whom was a Russian student working in her laboratory, an interview was secured. She was most friendly and kind and showed me in the basement of the Institut du Radium, 26 rue d'Ulm, some pieces of the experimental equipment used in the work and experiments that won for her and her husband the Nobel Prize in 1935 for demonstrating artificial radioactivity. It was part of the apparatus in the historic experiment demonstrating radioactivity in aluminum after bombardment with alpha particles, the aluminum being converted to radioactive phosphorus.

I think the most definite impression carried away from this interview with Mme. Joliot-Curie was the strong feeling she had in regard to the scientific sacrifice she and her husband made during the war when the workers in their laboratory (Halban and Kowarski) escaped to England in 1940

FIG. 3. Mme. Joliot-Curie, October 17, 1945.

with the total European supply of heavy water, plus the scientific and experimental ideas of the Joliot-Curie laboratory, then to go to the United States to carry on the work toward completing an atomic bomb. All the while the Joliot-Curies were to remain in France and do none of this important work, lest it be confiscated or obtained by the Germans during the occupation. I had the impression that it was a very difficult thing—a very painful thing—for these two great Nobel Prize winners to be in a position where the work on releasing atomic energy which they had so far advanced had to be brought to a halt *voluntarily* for four long years while the torch which they lit was carried to America.

The only opportunity I had to see and hear Frederic Joliot was the evening of November 13 when I was fortunate enough to get into the grand amphitheater of the Sorbonne to hear his lecture on the atomic bomb and atomic energy. It was a lecture for the general public, recounting

Fig. 4. Dr. R. Ledoux-Lebard.

the history and basic principles of nuclear physics. A crowd of 10,000 Parisians had gathered in front of the Sorbonne with seating accommodations for not over 3,000. One can well imagine the enthusiasm and near rioting of this crowd trying to obtain admission to hear their own Nobel laureate discuss a subject of such terrifying importance to the world. Professor Joliot is Professor of Physics at the Collège de France where since the liberation they have resumed their work on nuclear physics with a substantial grant of money from the French government. The newspaper *Paris-Presse* for December 14 carried a lengthy article on the creation of a French "brain trust" of atomic energy consisting of Irene Joliot-Curie, Frederic Joliot-Curie, Francis Perrin, and Pierre Auger. The latter scientist, Professor of Physics at the Sorbonne, left Paris in 1941 to carry on work at the University of Chicago. This group is charged with developing atomic energy for the French government.

No more skillful radiologist or cultured gentleman belongs to the fraternity of radiology than Professor Ledoux-Lebard (Fig. 4). He is still very active carrying on his private practice at his home, 22 rue Clément Marot, and lecturing at the Faculty of Medicine of the University of Paris. He no longer gives full time to his service at the Salpêtrière. At present he is busy revising the new edition of his excellent book on "Radiodiagnostic" which, with the relief in the paper shortage, he and his editors (Masson et Cie) hope to have ready for sale by February or March, 1946. Several afternoons in his home were the most enjoyable I have ever had. His home has many rich treasures—furniture, tapestries, art objects, all of the Empire period (Napoleon I). Many of these priceless objects would merit exhibit space at the Louvre itself. His library has some of the most priceless books. One in particular I recall was an 1806 edition of Corvisart, "Essai sur les maladies et les lesions organiques du coeur et des gros vaisseaux." This handsomely bound copy had belonged to Jerome, brother of Napoleon. I was Dr. Ledoux-Lebard's guest at the memorial services for Röntgen held by the French radiologists at the Maison de la Chimie, 28 rue Saint-Dominique, Friday, the 14th of December, the program of which is seen in Figure 5.

On bidding goodbye to this dean of French radiologists—who is no less an authority on the art and culture of the French Empire period—one cannot but imagine how truly complete and inspiring a service as student or intern in radiology under him would be. How fortunate must be all those

students of his who have had this priceless opportunity!

At the Hôpital Broca, the teaching hospital for gynecology of the University of Paris Faculty of Medicine, a great amount of work on examination of the female generative tract with contrast media is performed. Drs. Raoul Palmer and Jean Pulsford are extremely interested in roentgenological studies in gynecological conditions. Dr. Palmer and his wife had already left for a lecture tour in the United States just prior to my series of visits at Broca. Dr. Pulsford was most kind and gracious in demonstrating their work. They do a great number of lipiodol studies (uterosalpingography) each week at this hospital. Their technique in these studies rivals that of mucosal relief studies of the gastrointestinal tract in this country, in that lipiodol is injected under roentgenoscopic control and a series of three or four spot roentgenograms are taken during the study. In the United States, by and large, the roentgenologist is content to make statements about the patency of the tubes. At the Broca no hesitancy is shown in reading uterograms for filling defects and pathological changes few roentgenologists in America would feel qualified to interpret. This has been possible by a new technique developed by Drs. Raoul Palmer and Jean Pulsford on the service of Professor Pierre Mocquot, professor of clinical gynecology at Broca. The technique differs essentially in two ways from that employed elsewhere: (1) a study of uterine images with the thinnest possible layer of opaque material, and (2) a precise manometric study (done at time of roentgen study) which gives special information on the functional tone of the uterine muscle. The first of these differences is made possible by use of a new type of lipiodol (lipiodol fluide) with the same iodine content but about six times more fluid than ordinary lipiodol; the second by use of a special apparatus with following characteristics: (*a*) a syringe in which each half turn of the piston injects 0.5 cubic centimeter of the fluid lipiodol, (*b*) a Richard manometer, very sensitive and capable of reading uterine pressures more rapidly (by virtue of less inertia in the manometric system) and specially constructed joints and connections for firm

CINQUANTIÈME ANNIVERSAIRE
de la Découverte des Rayons X
par Wilhelm Conrad ROENTGEN

■

Les SOCIÉTÉS
D'ÉLECTRO-RADIOLOGIE MÉDICALE DE FRANCE,
FRANÇAISE D'ÉLECTROTHÉRAPIE ET DE RADIOLOGIE,
DES INGÉNIEURS CIVILS DE FRANCE
FRANÇAISE DES ÉLECTRICIENS,
FRANÇAISE DE PHYSIQUE,

vous prient d'assister aux CONFÉRENCES qui auront lieu le

VENDREDI 14 DÉCEMBRE 1945

au Grand Amphithéatre de la Maison de la Chimie
28, Rue Saint-Dominique, PARIS

pour commémorer la découverte de ROENTGEN, sous la Présidence d'Honneur de Monsieur le Ministre de la Santé Publique et de Monsieur le Recteur de l'Académie.

LA SALLE SERA CHAUFFÉE T. S. V. P.

PROGRAMME

VENDREDI 14 DÉCEMBRE, à 9 h. 30 précises

Hommage aux Victimes des Rayons X.
par M. le Dr DARIAUX, Secrétaire-Général de la Société d'Electro-radiologie médicale de France.

Vie et Travaux de ROENTGEN.
par M. J. CHEVALIER, Membre de la Société des Ingénieurs Civils de France.

Évolution du matériel radiologique.
par M. PILON, Président de la Société Française des Électriciens.

VENDREDI 14 DÉCEMBRE, à 14 h. 30 précises

Les Rayons X dans le Diagnostic Médical.
par M. le Dr LEDOUX-LEBARD, chargé du cours de Radio-diagnostic à la Faculté de Médecine.

Les Rayons X en Thérapeutique.
par M. le Dr J. BELOT, Electro-Radiologiste Honoraire des Hôpitaux.

Applications Industrielles des Rayons X.
par M. Paul BASTIEN, Professeur à l'Ecole Centrale des Arts et Manufactures.

Les Rayons X et la Recherche Scientifique.
par M. Maurice DE BROGLIE, de l'Académie Française.

Fig. 5. Program commemorating the Fiftieth Anniversary of Röntgen's discovery.

junction with the uterus. By slow, discontinuous injection of the fluid lipiodol under roentgenoscopy and the taking of films with only a thin layer of opaque material spread over the uterus as well as films made with the uterus full, these workers have many beautiful roentgenograms demonstrating polyps (as causes of metrorrhagia) clearly seen on several roentgenograms taken with the thin layer of lipiodol which were not at all visible with the "filled organ" technique—the customary single film made with the opaque ma-

terial filling the uterus. Withal it is a nice application of the technique of visualization of uterine mucosal pattern with a minimum of contrast material as has been done in barium examination of the stomach and duodenum, with, of course, the limitations imposed by the anatomical position and structure of the uterus.

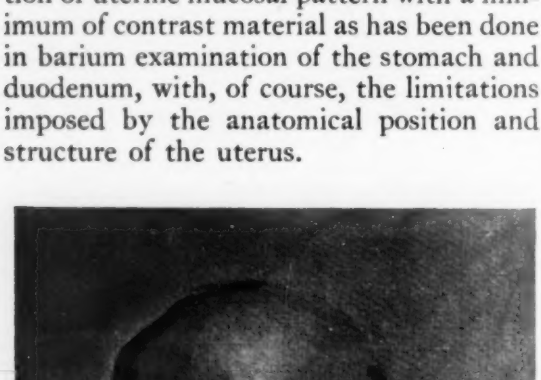

Fig. 6. Dr. Marcel Joly, médecin électro-radiologiste de l'Hôtel-Dieu.

Louis Victor, Prince de Broglie, called Prince because of that peculiar duality of France whereby many of its citizens are of royalty and would merit titles if a monarchy existed, presided over a lecture-conference at the home of the Comité France-Amerique, 9 Avenue President Roosevelt, December 1, 1945. The lecturer was Dr. Ralph B. Kennard, professor at Wilson Teachers College, Washington, D. C., who spoke in French on "La science aux Etats-Unis pendant la guerre." Dr. Kennard had been teaching at the United States Army University at Biarritz. It was, indeed, a happy privilege to see and hear and to obtain the autograph of Prince de Broglie, a Nobel Prize winner in physics for 1929. It was he who suggested the possibility that electrons can behave as if they possessed an associated wave, and proposed a formula for the wavelength of an electron in which the greater the velocity of the electron, the less is its wavelength. It was his theoretical considerations that formed the basis of the electron microscope. He continues to work at the Institute Henri Poincaré, 11 rue Pierre Curie, and resides in the Paris suburb of Neuilly.

Dr. Marcel Joly (Fig. 6) is one of the most amiable and enthusiastic of our French colleagues. He is chef de service at the large and venerable Hôtel Dieu, 2 rue d'Arcole, across the street from the ancient and beautiful Notre Dame Cathedral. He has an enormous department with every type and piece of radiological and electrological apparatus. They have a very heavy therapy load and at the time of my first visit there were two Picker U. S. Army Field Units doing yeoman service in superficial therapy. These had been obtained by the French government because of the large number of indigent therapy patients to be cared for at this hospital. Dr. Joly is surrounded by a large group of assistants and students at the Hôtel Dieu who have continued their work during the great difficulties of the occupation, Dr. Joly himself serving as President of the Société de Médecine de Paris during the occupation year of 1943. The picture of Dr. Joly was painted by his pretty and charming wife, who is a very talented artist. The writer enjoyed seeing her work at the Salon d'Hiver, at the Musée des Beaux-Arts de la Ville de Paris. Dr. and Mme. Joly were most liberal in their hospitality and many kindnesses.

In France medical care is on a broad governmental insurance basis. The agency responsible for this medical care is called Assistance Publique. It has had two important coverages so far in its history. At the beginning any person receiving a salary and who fell into what in this country would be called the "low income group"

was entitled to medical care and hospitalization. This still left those individuals in higher income brackets as private patients for physicians, surgeons and radiologists. But recently *anyone* receiving a salary whether he is president of the corporation or very low salaried employee is included in the law and may receive hospital and medical care under Assistance Publique. I learned two interesting things about this system: (1) 7 per cent of all money spent on Assistance Publique is represented in fees to the doctor. Not very much, is it? In our language it would be seven cents out of each government dollar spent covers the professional man's fee in France. (2) The chief battle going on at present in French socialized medicine is whether the *patient* can pay his doctor from Assistance Publique money paid *to* the patient or whether the doctor is to be paid by the Assistance Publique directly. The government wants the insurance system to pay the doctor and the doctors want the patient to pay the doctor. This may sound like a purely academic question but it is one that in the long run involves doctor-patient relationships and the free choice of the doctor by the patient. At present the French patient has this free choice. The French physicians may win this round. A year or so before the war they exhibited a solidarity and a "unionism" I doubt if the physicians in America could show when they went on a strike—absolutely and completely refusing to do work for the Assistance Publique unless they reduced their red tape and paper work from some nine or ten copies to a more reasonable five copy affair. They won their point. It would seem that when governments choose to consider physicians as members of a very highly skilled union or "syndicat" that the doctors should not disappoint the governments but proceed to act as such—and perhaps be heard.

Dr. Paul Cottenot is the radiologist of the Hôpital Saint-Louis, the teaching hospital for diseases of the skin for the University of Paris. At that hospital he is associated with the master of dermatology, Henri Gougerot. Every Friday morning between 10–12 noon the teaching clinics in skin diseases are held at this institution and the wealth of clinical material is truly amazing. The most interesting work Dr. Cottenot had to show was a little over one year's experience with a rather unique massive dose technique by contact (Chaoul) therapy in skin epitheliomas, administering without filter a dose of 10,800 r in one minute. The results are excellent and the cicatrices very satisfactory, choosing of course, lesions which are superficial and of very small area, not over 2.5 to 3 cm. in diameter or over 1 cm. deep. Plantar warts, small keloids and small hemangiomas, among the nonmalignant cutaneous lesions, are usually treated by contact therapy. This is no new field of therapy, naturally, but he points out the chief advantages of contact therapy in very busy hospital services, namely, the rapidity and simplicity of application.

It is impossible for mere words to express to Americans how the French were treated during the occupation and how much this war has cost them in loss of life (Allied strategic and tactical bombings) and property, plus the loss of life at the hands of the Gestapo and among the political deportees to the hellish concentration camps. More French civilians were killed during the war than American soldiers during the invasion and Battle of France. Political prisoners deported to Germany totaled nearly two million. This added to the terrific loss of manpower to France in World War I has been a staggering blow! One wonders how the country functions at all.

No medical publications of any major importance were permitted the French during the occupation. Some of the medical publications are now being printed. In our own field only the *Journal de radiologie et d'électrologie* printed by Masson et Cie is appearing and is serving the added duty of being the means of publication of papers and proceedings of other radiological so-

cities of France until the paper shortage is corrected and the finances and other administrative functions of these societies can be resumed. For example, the *Bulletin et mémoires de la Société d'électrologie médicale de France* is being published as part of the *Journal de radiologie et d'électrologie* at the present time.

The loss of many radiologists, members of the Société d'électrologie médicale de France, victims of four years of German bestiality, was mentioned by President Cottenot at the meeting of this society on December 12, 1944. He paid homage and tribute to those who had been lost and though the list is incomplete, especially from the provinces, it is already long. To mention a few: Dr. Hollweck, assassinated in prison; Dr. Morel-Kahn, killed in exile; Dr. Dupeyrac, shot at Marseille; Dr. Blineau, shot at Nantes; Dr. Soulié, at Tulle; Dr. Périgord of Limoges deported to Germany. The new president of the Society, succeeding Dr. Cottenot, is Professor Didiée of Hospital Val-de-Grâce recently returned from captivity in Germany. He assumed the presidency at the meeting of February 13, 1945.

Despite the greatest difficulties and deprivations the radiologists of France are attempting to return to a normal activity of their societies, their journals and publications, and most important of all, their daily lives. Our brave, patriotic and gifted French colleagues command the respect and admiration of all of us.

Despite the tremendous material difficulties surrounding them at the time of my visit—j'aurai toujours dans mon coeur un coin fort tendre pour la France et pour les électroradiologistes français.

712 Hume-Mansur Bldg.
Indianapolis, Indiana.

Vol. 55, No. 5

FROM THE MEMOIRS OF A STUDENT IN RÖNTGEN'S LABORATORY IN WÜRZBURG HALF A CENTURY AGO

By HERMANN HILLE, PH.D.
CHICAGO, ILLINOIS

DURING the last few years I have been urged by several medical friends to jot down whatever I may remember of my contact with Röntgen. I am glad to comply with their request and befittingly choose this year of 1945 for that purpose, for it is not only the golden anniversary of Röntgen's discovery of the x-rays, but also the centennial anniversary of his birth, March 27, 1845.

Much has been written in the course of half a century on the roentgen ray and its discoverer. Therefore I shall confine myself principally to what I know from personal experience and observation. It may be appropriate to mention here that the official records of the alma mater Julia in Würzburg as well as those in my possession, which many of my friends have seen, certify that I was enrolled at the Julius-Maximilian University of the ancient, picturesque and romantic city of Würzburg in Bavaria for eight consecutive semesters, from the winter semester of 1894 to the end of the summer semester of 1898. Four of these eight semesters included lectures and laboratory work at the Physikalische Institut of the university under the guidance and direction of Professor Röntgen. As shown, this included the historical year 1895 in which Röntgen discovered the up-to-then unknown, mystic rays to which he logically gave the name "x-rays."

It always seems desirable to visualize a great man and his achievements in their natural setting and surroundings. Hence I shall begin this little narrative with a very brief historical sketch of the university where Röntgen labored for so many years and achieved his crowning triumph.

The University of Würzburg (Herbipolis) is a very ancient institution. Its first beginnings date back to the year 1402, ninety years before Christopher Columbus sailed into the unknown West and more than a hundred years before the civilized world knew there existed such a continent as America. In that year, 1402, Bishop Johann von Egloffstein obtained from Pope Boniface IX a permit for the founding of a *universitas litterarum*. But its life was very short. After barely thirty years it expired as the result of malnutrition, partly because of the death of its founder and insufficient endowments, and partly because of the turbulent political condition of the times.

Several attempts at revival also were of short duration, until the exceptionally gifted and wealthy Prince Bishop Julius Echter von Mespelbrunn was successful in carrying out his most cherished plans and hopes, the establishment on a firm and permanent basis of the University, which now in the year 1945, with excusable pride of achievement, is able to look back upon an uninterrupted history of three hundred and sixty-three years of brilliant achievement.

Among the most important buildings erected in those early days, and still in good repair and use—except perhaps for the recent bombings—are the huge University building and the equally huge Julius Hospital, the cornerstone of which was laid by the founder of the University on March 12, 1576, exactly two hundred years before our Declaration of Independence. He endowed the hospital richly with income-producing buildings, with 87,000 acres of forest, 5,000 acres of agricultural lands and 1,000 acres of vineyards in choice locations. This original endowment supplies, even in these difficult times, ample income to carry on the work of the hospital without financial difficulties. To obtain an idea of the size of the

income from the vineyards alone, the capacity of the wine casks in the hospital wineries totals in round figures one million liters.

These wines of the "Julius-Spital" are among the best in the world. I personally can vouch for the excellence of their quality, for I had plenty of opportunity during my eight semesters to become acquainted with their superior quality, on official and unofficial occasions.

Well do I remember the official banquet in celebration of the dedication of the magnificent new university building in 1896, which I had the honor to attend in full regalia, as the official representative of my fraternity. Among the honored guests best known to the medical profession were Quincke, the physicist from Heidelberg; Rudolf Albert Kölliker, the well known anatomist and biologist; Rudolf Virchow, the famous pathologist from Berlin; and Wilhelm Conrad Röntgen, who needs no introduction.

At the plate of each guest stood five or six different wine glasses for as many different kinds of wine of the choicest and most aged vintages from the cellars of the "Julius-Spital." When the contents of three or four glasses, in some cases refilled, had reached the goal of their destiny, had sharpened the wits, loosened the tongues and fired the imagination, it became profoundly interesting to watch the cloak of official dignity gradually being unbuttoned and eventually more or less discarded, and to listen to the jolly and ever more eloquent reminiscences and mutual eulogies of those great men.

In this wine-inspired eloquence, Quincke and particularly Virchow excelled. Röntgen was much more quiet and reserved. Truly, *in vino veritas*. But in spite of the general hilarity towards the end of the banquet, I did not hear one word that even bordered on vulgarity. It was a wonderful experience which I shall always value among the treasures of my long life.

As already stated, Röntgen discovered the x-rays in 1895. Personally, I never knew the day, or even the month, nor the circumstances on and under which the discovery occurred. Careful men do not prematurely speak about matters of importance. When his experiments had been carried far enough for publication he made his written report to the Physikalisch-Medizinische Gesellschaft in Würzburg under the title "Über eine neue Art von Strahlen (Vorläufige Mittheilung)" dated and signed, "Würzburg. Physikal. Institut der Universität. Dec. 1895, W. C. Röntgen." This report was received by the secretary on December 28, 1895. It was printed immediately and included in the 1895 volume of the "Sitzungsberichte" of this society on pages 132 to 141 (available to readers at the John Crerar Library, Chicago). His second report is in the 1896 volume, pages 11 to 19.

On January 23, 1896, Röntgen delivered his lecture, which included his preliminary report and his second communication ("II. Mittheilung"). This was received with tremendous ovation in the overcrowded lecture room of the Physikalische Institut. Towards the end of his lecture he took the x-ray picture of the right hand of Geheimrat von Kölliker, honorary president of the society. Von Kölliker's proposal at that meeting, to call the new rays "Röntgen rays," was enthusiastically and unanimously accepted.

Both Röntgen and Kölliker foresaw and predicted the great value of the x-rays in the service of medicine. That is the reason why Röntgen chose the Physikalisch-Medizinische Gesellschaft for his first announcement. This prediction was fully borne out; it was even exceeded before a single year had passed, as was shown by Dr. Albert Hoffa in his "Demonstration mit Röntgenstrahlen" at the meeting of the same society on November 12, 1896.

It may be of value and therefore not amiss to give the English version of a few sentences from the report of the Physikalisch-Medizinische Gesellschaft of Würzburg covering this meeting:

The speaker points out that the original ex-

pectations of medical science from the Röntgen rays have already been exceeded. Not only internal medicine has already had benefit, as for instance we are now able to detect cases of arteriosclerosis and study the movements of the heart, but surgery especially has profited. The detection of foreign bodies in the body, the possibility to photograph fractures and luxations, to detect tuberculous and osteomyelitic foci in the marginal ends of the bones, even in the hip bones, are extraordinarily great advances. But also theoretical medicine has the greatest profit from this discovery. Thus, we can for instance accurately observe, through the barium-platinocyanide screen, the movement of the heart, the movement of the ribs in respiration, the movement of the joints; furthermore, one can obtain by photography wonderful information about the inner structure of whole, unsawed bones; thus one can also follow accurately the first beginnings of bones in the embryo, etc. In conclusion the essayist demonstrated by means of his different apparatus, procured from Reiniger, Gebbert and Schall, transillumination of the human body by Röntgen rays and showed a large series of excellent photographs of all human surgical diseases and injuries, also the inner structure of the different bones, of the movements of the wrist, and finally of surgical operations of congenital diseases of the hip. Six square meters of the most interesting pictures of bones, a veritable modern dance of death.

Röntgen's painstaking thoroughness in his lecture room, in his laboratory, and in his writings is best revealed in his report on the x-rays. It covers the subject so fully and so accurately that little could be added in all these years. That report stands out as a shining example in the scientific world. It is the greatest monument of a truly great man. This is acknowledged even by those who did not have the privilege of observing Röntgen in his lectures and his work, but who have thoughtfully read and studied his report, as probably all specialists have.

The grotesque reactions which the discovery of the x-rays called forth in the early days is perhaps best illustrated by the following few examples:

In the New Jersey Legislature a law was proposed to prohibit the use of x-rays in opera glasses. A firm in London advertised "X-Ray-Proof Clothing for Modest Women." One columnist believed it possible to imprint directly upon the brain of medical students anatomical pictures by means of the x-rays. The *Pall Mall Gazette* of London exclaimed: "We are sick of the Röntgen rays. It is now said, we hope untruly, that Mr. Edison has discovered a substance—tungstate of calcium is its repulsive name—which is potential, whatever that means, to the said rays. The consequence of which appears to be that you can see other people's bones with the naked eye, and also see through eight inches of solid wood. On the revolting indecency of this there is no need to dwell. But what we seriously put before the attention of the Government is that the moment tungstate of calcium comes into anything like general use, it will call for legislative restriction of the severest kind. Perhaps the best thing would be for all civilized nations to combine to burn all works on the Röntgen rays, to execute all the discoverers, and to corner all the tungstate in the world and whelm it in the middle of the ocean. Let the fish contemplate each other's bones if they like, but not us." It was fortunate for Röntgen and Edison that this pious and Christian wish was not fulfilled.

I did not know Professor Röntgen intimately, or even socially. I merely knew him as an interested student would know his teacher. But his first assistant, Dr. Otto Stern, was a member of my fraternity and he and I were intimate friends. Through him I had the great privilege of being present at the Physikalische Institut one evening when Röntgen demonstrated the startling property of the x-rays to a small group of about twenty university and government officials.

On the lecture table was a Crookes tube clamped to a stand at a height of about a foot above a photographic plate holder (Kassette) and its two poles attached to the largest Ruhmkorff coil then in the possession of the Institut. When the audience had listened to a brief lecture on the production

and properties of the x-rays, one of the audience, whose identity has escaped my memory, was invited to place his hand on the plateholder. Then Röntgen switched on the current, exposing the hand to the relatively feeble x-rays emanating from the Crookes tube, for what seemed to me about half a minute. When the assistant after a few minutes reappeared from the darkroom and Röntgen held the developed plate in front of a source of dispersed light, the effect upon the audience was startling, electrifying. To see, while still alive, one's own bones, seemed to me at least like a miracle and a message from another world.

Today, half a century later, I have often wished Röntgen could see the phenomenal development and importance of his discovery not only for medicine but also for practically every branch of science and industry, much of which he had foreseen and predicted. Yes, if he could see, how his loyal heart would swell, not with foolish and childish pride, but with gratitude and humility for having been the channel through whom this great boon was given to humanity. And yet who knows? If the fundamental teachings of all great religions are based on fact, maybe he does know.

Professor Doctor Wilhelm Conrad Röntgen made a magnificent, patriarchal appearance. He was at least six feet tall; broad-shouldered, with deep, wide chest; thick, dark hair and long, full beard; large head and symmetrical, noble features; and always immaculately dressed, probably thanks to his good wife whom I never met.

Röntgen was very reserved. I do not know whether he had a sense of humor or not. At any rate, in the laboratory he was a strict and exacting disciplinarian. But so were his two assistants. Physics is an exacting science. In the lecture room, too, he was very serious, very matter of fact. That, together with the numerous equations and intricate mathematical formulae, which he wrote on the blackboard, did not make the lectures particularly attractive, except perhaps for the few mathematical enthusiasts. And, to top it all, the time of the lectures was from two to three o'clock in the afternoon, too soon after the customary early dinner when the blood supply of necessity was concentrated in a region considerably lower than the brain. This condition was still further aggravated, sometimes almost to the limit of endurance, on hot sultry summer days.

I do not wish to convey the impression that Röntgen's lectures were more dry and less attractive than the lectures of other physicists of those distant days when there existed none of the modern facilities which tend to make even the driest subjects more or less interesting. Röntgen is not the only physicist whose lectures I heard and in whose laboratory I worked. For four semesters I was enrolled at the University of Heidelberg where I heard Quincke and worked in his laboratory. True, his lectures were more lively, because he was of a more volatile type. But, on the other hand, Quincke did not convey the same sense of stability and solidity that Röntgen radiated.

Lest I be misunderstood, let me emphatically say that I am not criticizing either of these men. I sat at the feet of both and am grateful for what I received from them. Each was competent in his own way. They were merely two different types.

For recreation Röntgen enjoyed stalking the elusive deer, not for the sake of killing a harmless animal but for the exercise of long hikes through vine- and forest-clad hills surrounding beautiful ancient Würzburg, and the thrill every true sportsman and disciple of Nimrod obtains from the display of skill necessary for the successful stalking of a wary animal in whom the senses of hearing, smelling and seeing are unusually developed. I have seen him walking from the Physikalische Institut in the late afternoon, in a becoming, attractive hunting outfit, the trusty gun slung over his right shoulder, with eager strides to reach the distant woods before sunset.

As an illustration of his keen sense of loyalty to principle, the following incident as related to me by his first assistant, Dr.

Otto Stern, will serve. Some weeks after the startling discovery of the x-rays had been published, an American came to see Röntgen and offered him the tidy sum of $50,000.00, which was equivalent to 200,000 marks, for a lecture tour of the principal cities of the United States. Röntgen courteously but firmly refused. No attempts at persuasion could budge him. Finally the promoter went to Dr. Stern, offering him $25,000.00, or 100,000 marks. He, too, refused, on the same principle which prompted Röntgen to refuse. They felt that because their salary was paid by the government, they had no right to exploit for personal gain the results of their labors, performed in a government institution and at government expense. When one considers that the salary of the first assistant was barely enough to cover his frugal living expenses—if I remember correctly it was about 1,500 marks a year, certainly not more than 1,800 marks—then the refusal of what would have enabled the recipient to live in comfort the rest of his life becomes all the more heroic. One may wonder how many men in our modern world, in which almost everything seems to be for sale, would have regarded such a refusal as impractical or even utterly foolish and would have accepted so tempting an offer without a moment's hesitation.

But, whatever the attitude or criticism on the part of other people may be, one thing is certain and beyond criticism and dispute, and that is that both of these great men, Röntgen and Stern, proved and demonstrated their greatness under severe and sore temptation by living up to their high ideal of honor. Men of a higher standard of honor and integrity I have yet to find, after half a century since that experience.

It seems to the writer that humanity, in high and low places, will have to return to such idealism and loyalty to principle if it would save itself from utter destruction. Today those who have "eyes to see" cannot fail to observe where the almost complete abandonment of principle for the sake of "policy," now a mere camouflage for selfishness, is leading blindfolded humanity. At any rate, to come back to our subject, one cannot but wonder whether Röntgen and Stern were so foolish after all to sacrifice great immediate advantage for the sake of "impractical" principle. Both of these great men have departed from their physical bodies and this physical world, and both have their sense of loyalty intact and unsullied, a treasure which we can take with us—if we have it. Money and other material things, though very necessary and useful here, we cannot take with us and have to leave behind when our time for "shuffling off this mortal coil" arrives. And what have we then, if the accumulation of material possessions has been our sole aim in life, often with little regard for principle?

That, however, is a matter which everybody has to decide for himself. No one else can do it for him. But it is a subject of such far-reaching consequences that it is wise, if only from the point of self-interest, to ponder well and dig deep, deep into. And with diligence and perseverance, we are bound to uncover treasures which far outshine all possible material accumulations and emoluments. "Seek and ye shall find" are not mere idle words. They are good, sound, practical advice.

And when we have found, we shall owe that good fortune to the zeal instilled by the shining example of the two great men, Röntgen and Stern.

1791 Howard St.
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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Forty-seventh Annual Meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 17–20, 1946.

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Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Twenty-eighth Annual Meeting: Assembly Hall, Health Center, San Francisco, Calif., June 28–29, 1946.

EDITORIALS

THE ROENTGENOGRAPHIC ASPECTS OF POLYCYTHEMIA VERA

THE pulmonary changes as demonstrated roentgenographically in polycythemia vera are well known, having been described by Hirsch[1] and by Hodes and Griffith.[2] The observations of Hodes and Griffith on the pulmonary changes were of great importance in that their observations of roentgenograms of the chest of individuals with polycythemia enabled them to differentiate between polycythemia vera and polycythemia due to pulmonary arteriolosclerosis. Cases with polycythemia vera presented abnormally prominent bilateral vascular markings roentgenographically and these changes were not observed in polycythemia secondary to pulmonary arteriolosclerosis; on the contrary, the latter group revealed unusual prominence of the right heart and pulmonary conus, the middle and bilateral zones of the lungs being essentially normal. These observations are of considerable clinical importance in the treatment of polycythemia.

Until recently no detailed report had been given dealing with bone changes due to polycythemia vera and no information was available as to whether any attempt had been made to determine if bone changes existed in polycythemia vera.

Hodgson, Good and Hall[3] have just reported in detail their studies on a group of cases suffering from polycythemia vera. They were stimulated in their study by the fact that a careful search of the literature failed to reveal any references to changes in the bones associated with polycythemia vera.

In their examination of roentgenograms of the skeleton they attempted to determine whether there were any changes of the bones caused by polycythemia and whether any lesions of the bones could be found to be frequently associated with polycythemia vera that would enable one to diagnose polycythemia from the skeletal roentgenograms.

The roentgenograms of the skeleton were divided into two large groups, namely, roentgenograms of the extremities and those of the trunk and pelvis. In the roentgenograms of the extremities nothing was revealed that was not already known. They observed calcification of the peripheral vessels in about half of the cases and this observation confirmed the previous work of Brown and Giffin.[4] They also noted a certain amount of osteoporosis in a number of cases but in an effort to determine the value of this observation in a differential diagnosis they found it extremely difficult as many of their cases were in the age group where a senile type of osteoporosis would under normal conditions prevail.

The roentgenograms of the spinal column and the pelvis also failed to reveal any diagnostic evidence which could be associated with polycythemia.

Since a number of their cases were undergoing treatment with radioactive phosphorus an effort was made to determine whether there might be any changes of the

[1] Hirsch, I. S. Pulmonary changes in polycythemia vera. *Radiology*, 1936, *26*, 469–473.

[2] Hodes, P. J., and Griffith, J. Q. Chest roentgenograms in polycythemia vera and polycythemia secondary to pulmonary arteriolosclerosis. Am. J. Roentgenol. & Rad. Therapy, 1941, *46*, 52–58.

[3] Hodgson, J. R., Good, C. A., and Hall, B. E. The roentgenographic aspects of polycythemia vera. *Proc. Staff Meet., Mayo Clin.*, April 3, 1946, *21*, 152–157.

[4] Brown and Giffin. Quoted by Hodgson, Good and Hall.

bones due to this form of therapy. A careful analysis of this group of cases failed to reveal any important recognizable changes.

Similarly a study of the roentgenograms of the skull and sinuses failed to give any clue to a possible differential diagnosis in polycythemia. The examination of the thorax in their cases confirmed the previous observations of Hodes and Griffith regarding the pulmonary changes in polycythemia vera. They also found in their cases varying degrees of cardiac enlargement and they observed that parenchymal involvement, completely divorced from cardiac enlargement, occurred frequently enough in cases of polycythemia to warrant assumption of a definite relationship: that is, that the increased vascular markings occurred in many of the cases without any demonstrable evidences of cardiac enlargement, thus confirming the observations of Hirsch, and of Hodes and Griffith.

The analysis of their group of cases regarding the gastrointestinal lesions confirmed the observations which had previously been made concerning the association of polycythemia and peptic ulcer. The roentgenograms of the gallbladder did not suggest any relation to polycythemia.

While the pulmonary changes in polycythemia vera and polycythemia incident to pulmonary arteriosclerosis are well established, it is of considerable importance that Hodgson, Good and Hall made a complete roentgenographic examination of the bones in cases of polycythemia vera, even though their examination revealed nothing in the way of a differential diagnostic feature. It is also of considerable interest that the examination of the roentgenograms of patients undergoing treatment with radioactive materials failed to disclose any lesions of the bones which could be associated either with the treatment or with polycythemia vera. However, the length of time these patients were under treatment with radioactive materials was not indicated.

While the etiology of polycythemia vera still remains unknown such studies as Hodgson, Good and Hall have made, while of a negative character, add considerably to the known features of the disease. It might be of interest when the opportunity arises to make roentgen-ray diffraction studies of the bone tissues to see if there is any change in the orientation of the molecules which differs from the normal.

JAMES BELL BULLITT
1863-1946

DR. JAMES B. BULLITT died on February 25, 1946. This brought to a close the career of another of the pioneers in radiology. At the time of his death, Dr. Bullitt was senior living ex-president of the American Roentgen Ray Society, having held that office in 1904. He served the Society as secretary the two preceding years.

Dr. Bullitt graduated from the University of Louisville Medical School in 1889 and then took some graduate work in Germany and a service in a New York hospital. He practiced in Louisville for a few years, then, because of his health, went into the

Southwest to practice for a while. After moving to California, several years followed when he was not in the active practice of medicine, but took up farming. However, about 1920, the urge to return to his old work could not be denied, so he took some review work with Dr. Howard Ruggles at the University of California Hospital and, in 1921, joined me in the practice of radiology, an association which lasted until the time of his retirement, twenty-four years later.

I am sure we will all agree that this was somewhat of a record time for two doctors to live in peace together. This was in great part made possible by the fact that, while he was a strong minded and determined person, Dr. Bullitt was also a very considerate one. His willingness to see other people's viewpoints and give them due regard made such an association possible, and a most congenial one. Dr. Bullitt used to say it was something like being married, one had to put up with a lot of things in the interest of general peace.

His contributions to the medical literature were not many. His chief contribution was to the practice of radiology, as it was expressed in his warm and sympathetic relations with patients. He did make one contribution, however, that has been most valuable, namely, the designing of the Bullitt mastoid device, with which stereoscopic views of both mastoids can be taken without moving the patient from a comparatively comfortable supine position. This apparatus has had wide use throughout the country.

Even in his advancing years, Dr. Bullitt maintained a remarkably youthful outlook on life and his professional activities. He enjoyed the association with young medical men, as interns and residents in the Santa Clara County Hospital, where he served as visiting radiologist. He was always interested and eager to discuss the medical problems with these younger men, and frequently said he himself learned a great deal from them.

He was active in local community affairs, having held office for many years in the local Red Cross Chapter, and, also in the San Jose Rotary Club, which he once served as president.

Dr. Bullitt leaves his wife, Edith Selby Bullitt, and five children.

Charles M. Richards

ROBERT GLENN ALLISON
1887-1946

ROBERT GLENN ALLISON died suddenly, March 20, 1946, in Minneapolis, Minnesota, following a cerebral hemorrhage.

Dr. Allison was the son of William Meek Allison and Nancy Eliza Glenn and was born at York, South Carolina, November 25, 1887. He attended York High School and graduated from the University of Maryland Medical School in 1912. After his internship at the Trudeau Sanatorium, Saranac Lake, N. Y., he did graduate study there and at Cornell University until 1915. From 1915 to 1917 he served on the

resident staffs of the Municipal Tuberculosis Sanatorium, Chicago, and the Pokegema Sanatorium, Pine City, Minnesota.

Dr. Allison entered the Army Medical Corps in World War I in 1917. He received training in radiology under Colonel Lewis Gregory Cole in New York and was later assigned to hospitals in Bordeaux and Paris. He was discharged from the Army as Captain, Medical Corps, in 1919. Following his discharge from the Army, Dr. Allison went to Detroit where he served as Radiologist on the staff of Harper Hospital. In 1920 he was appointed Clinical Professor of Radiology at the University of Minnesota Medical School. He established a private practice in Minneapolis and St. Paul and served on the staffs of Northwestern, Asbury, and Abbott Hospitals, and the Glen Lake Sanatorium. Associated with him in practice in Minneapolis have been Malcolm B. Hanson, Cyrus Owen Hansen, David A. Burlingame, Robert Nord, Ralph Iverson and Russell W. Morse.

Dr. Allison was a member of the Hennepin County and Minnesota Medical Societies, the American Medical Association, the American Roentgen Ray Society, the American College of Radiology, the Radiological Society of North America, the Minnesota Radiological Society, the Minnesota Academy of Medicine, and the American Association for the Advancement of Science. He was a former president of the Minnesota Radiological Society and he served on the Medical Panel of the Minnesota State Industrial Commission dealing with cases of silicosis. He was a member of the Minnesota, Minneapolis, and Minnekahda Clubs.

Articles by Dr. Allison have appeared in *Minnesota Medicine*, *Journal-Lancet*, the American Journal of Roentgenology and Radium Therapy, and, in translation, in *Revista de radiologia y fisioterapia*.

Dr. Allison is survived by his wife, Helen Bullitt Lowry Allison; a daughter, Margaret Glenn Allison; a sister, Sue Meek Allison of York, South Carolina, and a brother, William Meek Allison of Columbia South Carolina.

Thomas McG. Lowry

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 17–20, 1946.

American College of Radiology
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting, Palace Hotel, San Francisco, Calif., June 29, 1946.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: San Francisco, Calif., July 1–5, 1946.

American Radium Society
Secretary, Dr. E. H. Skinner, 1532 Professional Bldg., Kansas City, Mo. Annual meeting: Assembly Hall, Health Center, San Francisco, Calif., June 28–29, 1946.

Arkansas Radiological Society
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1–6 1946.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology, California Medical Association
Secretary, Dr. Gordon G. King, 3700 California St., San Francisco 18, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles Co. Med. Assn.
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N.Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Denver Radiological Club
Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Secretary, Dr. J. F. Pitman, Blanch Hotel Annex, Lake City, Fla. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N.H. Meets four to six times yearly.

Radiological Society of New Jersey
Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting, Carolina Hotel, Pinehurst, N. C., May 1, 1946.

* **Secretaries of societies not here listed are requested to send the necessary information to the Editor.**

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport. Annual meeting, Berkshire Hotel, Reading, Pa., May 17–18, 1946.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets 6:30 P.M. at The Ruskin on second Wednesday, each month, October to May inclusive.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Mid-Summer Conference, August 8, 9, 10, 1946, at Shirley Savoy Hotel, Denver, Colorado.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly on first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA
Secretary, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta, 218, Lima.

CONTINENTAL EUROPE

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. Babaiantz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

AMERICAN RADIUM SOCIETY

The American Radium Society will hold its annual meeting at San Francisco, California, June 28 and 29, 1946, under the presidency of Dr. W. E. Costolow of Los Angeles. The scientific sessions will be held at the Assembly Hall of the Health Center. The officers of the Society will be registered at the Sir Francis Drake Hotel. The Janeway Lecture will be given by Dr. Frederick W. O'Brien of Boston. The Chairman of the Program Committee, Dr. Charles L. Martin, President-Elect, has arranged a most interesting program, with discussions. The Annual Banquet will be held Friday evening, June 28, at the Fairmount Hotel. The following is the program which will be presented:

Program

FRIDAY, JUNE 28, 1946

Morning Session

8:30 A.M.—Executive Session

9:00 A.M.—Scientific Session

1. Presidential Address. William E. Costolow, M.D., Los Angeles.
2. Radiation Therapy in Navy Personnel. Allen G. Robinson, M.D., New York.
3. Cancer of the Eyelid. Howard B. Hunt, M.D., Omaha.
4. Cancer of the Tongue. George S. Sharp, M.D., and Harold D. Spickerman, M.D., Pasadena.
5. Cancer of the Anal Canal. Orville N. Meland, M.D., Los Angeles.
6. Treatment of Nasal Polyps, Allergic Rhinitis and Allied Conditions with Radium. Edward H. Skinner, M.D., Kansas City.

FRIDAY, JUNE 28, 1946

Afternoon Session

2:00 P.M.—Executive Session

2:20 P.M.—Scientific Session

Chairman, Eugene Pendergrass, M.D., Philadelphia.

7. Recent Developments in Medical Physics with Reference to Radiation Therapy. Harding B. Jones, Ph. D., Berkeley.
8. External Use of Radioactive Phosphorus in Skin Diseases. B. V. A. Low-Beer M.D., San Francisco.
9. Metabolism of Radioactive Substances. Jas. G. Hamilton, M.D., Berkeley.
10. The Retention of Radioactive Iodine in Thyroid Carcinoma: Autoradiographic and Histologic Studies. L. Marinelli, M.A., F. W. Foote, M.D., and A. Hocker, M.D., New York.

4:00 P.M.—Janeway Lecture

Radium Treatment of Cancer of the Cervix; a Historical Review. Frederick W. O'Brien, M.D., Boston

FRIDAY EVENING, JUNE 28, 1946

Annual Banquet

Fairmount Hotel

SATURDAY, JUNE 29, 1946

Morning Session

8:30 A.M.—Executive Session

9:00 A.M.—Scientific Session

Chairman, Frank E. Adair, M.D., New York.

11. Hemangio-endothelioma of the Cervix. Harry H. Bowing, M.D. and Robert E. Fricke, M.D., Rochester, Minn.
12. Treatment of Cancer of the Cervix by the Bellevue Method. Ira I. Kaplan, M.D., and Rieva Rosh, M.D., New York.
13. Intravaginal Roentgen Therapy in Cancer of the Cervix. John S. Bouslog, M.D., Denver.
14. Treatment of Cancer of Cervix with Radium Needles. George W. Waterman, M.D., Providence.
15. The Wertheim Operation in Cancer of the Cervix. Joe V. Meigs, M.D., Boston.
16. Surgical Treatment of Cervical Cancer: the Wertheim Operation. Daniel G. Morton, M.D., San Francisco.

SATURDAY, JUNE 29, 1946

Afternoon Session

2:00 P.M.—Executive Session

2:20 P.M.—Scientific Session

Chairman, Charles L. Martin, M.D., Dallas.

17. A Cylindrical Radium Applicator for the Treatment of Surface Vaginal Lesions. E. F. Focht, B.A., and L. Marinelli, A. B., New York.
18. Radium Therapy in Benign Uterine Hemorrhage. Herbert E. Schmitz, M.D., Chicago.
19. Use of Testosterone in Treatment of Cancer of the Breast. Frank E. Adair, M.D., New York.
20. Radiation Therapy in Treatment of

Brain Tumors. Eugene P. Pendergrass, M.D., Philadelphia.

21. Radium Needles in Cancer of the Bladder. George Cahill M.D., Maurice Lenz, M.D., Meyer M. Melicow, M.D., and Charlotte P. Dolan, M.D., New York
22. A Consideration of Methods Employed in the Treatment of Recurrence and Metastases of Cancer of the Larynx. John V. Blady, M.D., Philadelphia.

AMERICAN ROENTGEN RAY SOCIETY

The Forty-seventh Annual Meeting of the American Roentgen Ray Society will be held at the Netherland Plaza Hotel in Cincinnati, Ohio, from September 17 to 20, 1946. This is the first meeting of the Society, except the Joint Meeting with the Radiological Society, that has been held since 1942. This, therefore, promises to be one of the most important meetings held and all the members of the Society are urgently requested to attend and to make their hotel reservations immediately since there still remains a dearth of hotel rooms available. Only those who make application early will be assured of a room at the hotel where the meeting is being held.

The President-Elect, Dr. Raymond C. Beeler, and his Program Committee have arranged an excellent program, and in addition to this interesting scientific program adequate preparations have been made for the Instruction Courses under the direction of Dr. B. R. Kirklin. The program of the Instruction Courses will be available shortly and all who anticipate attending these courses can then make application.

There will be the usual Commercial Exhibit and it is gratifying to be able to announce that the manufacturers have availed themselves of the opportunity to exhibit their roentgenologic equipment, which embodies many new features not only in construction but in the general overall improvements which have been planned during the war years.

Dr. S. W. Donaldson, the Chairman of the Scientific Exhibit Committee, and his committee members are arranging for a splendid exhibit and those who anticipate displaying a scientific exhibit at the forthcoming meeting should communicate at once with Dr. Donaldson.

In the light of the preparations that have been made and remembering the former meeting in Cincinnati, this forthcoming meeting should be not only of interest but of intellectual benefit and pleasure.

NEW ENGLAND ROENTGEN RAY SOCIETY

The annual meeting of the New England Roentgen Ray Society will be held on May 17, 1946, at the Harvard Club, Boston. The George W. Holmes Annual Lecture will be given by Dr. Arthur C. Christie of Washington, D. C., his subject to be "The First Fifty Years of Radiology: The Elements Which Have Contributed to Its Growth as a Great Medical Specialty."

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The Mid-Summer Conference of the Rocky Mountain Radiological Society will be held on August 8, 9 and 10, 1946, in Denver, Colorado. All of the sessions will be held at the Shirley Savoy Hotel.

THE FIFTIETH ANNIVERSARY OF THE DISCOVERY OF THE ROENTGEN RAY

Part of the observance in Rochester, New York, of the fiftieth anniversary of Röntgen's discovery of the x-ray was a public meeting and exhibit, Sunday afternoon, November 4, 1945, at the Rochester Academy of Medicine. Both were sponsored by the Rochester Roentgen Ray Society, the Rochester Academy of Medicine, the Medical Society of the County of Monroe, and the School of Medicine and Dentistry of the University of Rochester. The meeting was arranged in the auditorium of the Academy by the Committee on Public Meetings of the Academy under the chairmanship of Dr. Sol Davidson. The Roentgen exhibit, placed in the Museum Room of the Academy of Medicine, was organized by the Rochester Roentgen Ray Society.

The speaker at the public meeting was Dr. B. R. Kirklin, Head of the Section of Roentgenology, Mayo Clinic; Professor of

Radiology, Mayo Foundation, University of Minnesota, Rochester, Minnesota; and Chief Consultant in Radiology, with rank of Colonel, Medical Corps Surgeon General's Office, Washington, D.C. The title of Dr. Kirklin's presentation was "Röntgen and His Epoch-Making Rays." He first gave a brief review of Röntgen's life and personality. This was followed by a description of Röntgen's laboratory arrangements and activities at the time of the discovery. He then related how this achievement quickly fired public imagination and how knowledge of it was rapidly disseminated throughout the world within a few weeks.

The main portion of Dr. Kirklin's address was a lantern slide demonstration of various early and present-day applications of radiology in medical diagnosis and treatment, and in industry. The part devoted to the alimentary tract was particularly complete and instructive. Dr. Kirklin then traced the line of descent from the discovery of the roentgen ray to that of nuclear fission and the development of the atomic bomb. In discussing the potential application of atomic power, Dr. Kirklin said:

"Now the people of the earth must choose whether they will learn to use atomic energy for the benefit of man or permit it to be employed for his utter destruction. To the pessimist the outlook is dark indeed. He foresees a strong possibility that in the next war, assuming that there must be another war, civilization and perhaps the human race will be wiped out completely, or that by ignorance, accident or design all the atomic energy of the world will be detonated in one colossal fiery blast and thus fulfill the biblical prophecy. He wonders if the atomic physicist has unwittingly imitated Pandora whose curiosity led her to open that famous box and let loose all the ills of the world; he recalls those awesome lines in the Battle Hymn of the Republic, 'He has loosed the fateful lightnings of his terrible swift sword; Our God is marching on'; and he thinks he is beginning to understand why the Creator forbade Adam and Eve to eat of the fruit of the tree of knowledge.

"But the optimist has no such fears. He feels that as man has devised defenses against most other perils, he will manage to protect himself from the atomic bomb; that he will harness atomic energy and use this tremendous power to bring him comfort, health and happiness such as he has never envisioned in his most fanciful dreams.

"Each of us will adopt one or the other view, depending on his personal equation. But surely the great majority of people will look on the brighter side and hold firmly to the belief that this newest descendant of the roentgen rays will prove as beneficent to mankind as Röntgen himself would have willed it to be."

He concluded with a plea for the use of human conscience and intelligence in making atomic energy the servant, and not the destroyer, of mankind.

The Roentgen exhibit was arranged in thirteen sections as follows:

Section 1. *Röntgen and the Discovery of the X-ray.* This part of the story of roentgenology was depicted by portraits of Röntgen; photographs of his birthplace, laboratory, and equipment; prints of roentgenograms made by Röntgen; a specimen of a Crookes cathode-ray tube, and Ruhmkorff induction coil, of the types Röntgen employed, an early 1902 photographic plate holder, and a large historical photographic reconstruction of Röntgen at the moment of his discovery of the x-rays provided by the Eastman Kodak Company.

Section 2. *Röntgen Publications.* These included copies of Röntgen's three published papers on the x-rays, the paper published by Dr. Philip Lenard in 1894 on the behavior of cathode rays that stimulated Röntgen's own train of research, and the biographies, "Wilhelm Conrad Röntgen" (1934) and "Dr. W. C. Röntgen" (1945), by Dr. Otto Glasser.

Section 3. *Old Electrical Apparatus.* These were a Tesla coil, and two examples of static machines—one, hand driven; and one, motor driven, with Leyden jars attached as electric accumulators.

Section 4. *Early Discharge Tubes.* Included was the small cathode-ray tube used by Professor Henry E. Lawrence to make the first

Roentgenograms in Rochester. Three Geissler electric discharge tubes completed the unit.

Section 5. *Dr. Louis A. Weigel.* In the glass case were shown three papers on radiologic subjects written by Dr. Weigel; the book "American Martyrs to Science Through the Roentgen Rays" written by Dr. Percy Brown, and opened to the chapter on "Dr. Louis A. Weigel"; and the book "Orthopedic Surgery" by Dr. R. Tunstall Taylor in 1907 opened to the photograph of the first x-ray stereoscope introduced in Rochester by Dr. Weigel.

Section 6. *X-ray Equipment.* This group featured a Wappler X-ray Transformer, Control, and Gas Tube dating from about 1917 and five panels of photographs of modern roentgenologic equipment depicting the apparatus manufactured by the General Electric X-ray Corporation, the Kelley-Koett Manufacturing Company, the Picker X-ray Corporation, the Ritter Company, and Westinghouse Electric Corporation.

Section 7. *Before and After Röntgen.* This unit featured a chronologic chart "The Scientific Forefathers of Wilhelm Conrad Röntgen. Historic Steps in the Discovery of the X-ray" prepared by Dr. Otto Glasser, and forty-three portraits of individuals who contributed to the development of electricity and radiology before and after Röntgen's discovery.

Section 8. *Pioneer Radiology in Rochester.* In this part of the exhibit were shown portraits of Dr. Louis A. Weigel (1854-1906) and Dr. Fred D. Andrew (1856–1944), ten of the first glass plate roentgenograms made in Rochester by Professor Lawrence in 1896; glass plate roentgenograms made in Batavia in 1900; in Rochester by Dr. Weigel, 1902; and by Dr. Myron B. Palmer, 1919. Prints of roentgenograms made by Dr. Andrew between 1905 and 1910 were also shown.

Section 9. *Medical Applications of the X-rays.* This portion of the exhibit was devoted to the showing of forty-nine roentgenograms of a wide variety of normal and pathologic human conditions. These ranged in size from dental films and 35-mm. mass chest survey roentgenograms to a 36×72 inch roentgenogram of the entire human body.

Section 10. *The Development of X-ray Tubes.* Thirty-eight roentgen tubes and accessories were exhibited in seven vertical museum cases. The first two cases traced the development of gas roentgen-ray tubes from the Crookes cathode-ray tube of the type used by Röntgen in 1895 to the Macallister Wiggins Gas Tube (1910). The remaining five cases demonstrated the evolution of hot-cathode roentgen-ray tubes from the Coolidge Universal Tube invented in 1913 down to the present day. The tubes ranged in size from a small dental tube that fits in the palm of the hand to the 6 foot million volt tube. Various types of stationary- and rotating-target tubes were displayed including the original experimental model made by the General Electric X-ray Corporation in 1914. A specimen of the Westinghouse ultra speed x-ray tube for exposures of 1/1,000,000 of a second was also shown.

Section 11. *X-ray Humor.* Six cartoons and advertisements from 1896 and the present time.

Section 12. *X-ray Therapy.* This aspect of the exhibit featured Kodachrome transparencies, lantern slides, minicolor prints, and a roentgenogram of various malignant and other conditions showing their behavior to roentgen treatment.

Section 13. *War Radiology.* Twenty lantern slides of roentgenograms of injuries sustained during World War I.

In its entirety, the exhibit contained sixty specimens, 125 photographs, 79 roentgenograms, 61 kodachrome transparencies, 24 lantern slides, and 361 signs and captions.

TENNESSEE RADIOLOGICAL SOCIETY

The annual meeting of the Tennessee Radiological Society was held at the Andrew Johnson Hotel, Knoxville, Tennessee, April 10, 1946, during the annual meeting of the Tennessee State Medical Association. Dr. Robert A. Arens, Chicago, Illinois, was guest speaker. He gave an interesting and instructive talk on "Pneumoperitoneum." The following officers were elected for the coming year: *President*, Dr. Leon M. Lanier, Nashville; *Vice-President*, Dr. J. Cash King, Memphis; *Secretary-Treasurer*, Dr. J. Marsh Frère, Chattanooga.

It is also of interest that two of the new officers of the Tennessee State Medical Association—Dr. C. M. Hamilton, Nashville, elected President and Dr. F. B. Bogart, Chattanooga, President-Elect—are both radiologists and both are members of the Tennessee Radiological Society.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Classic Descriptions of Disease. By Ralph H. Major, M.D., Professor of Medicine, University of Kansas School of Medicine. Third edition. Cloth. Price, $6.50. Pp. 679, with 158 illustrations. Springfield, Illinois: Charles C Thomas, 1945.

This collection of two hundred and eighty-seven epoch-making contributions in the field of medicine is now obtainable in an enlarged and revised edition. Major has performed a real service for the medical profession in making these historic selections readily available in English to the medical student, teacher, investigator and the profession at large. Incorporated in the text are 158 carefully chosen illustrations of portraits, facsimiles of important texts, title pages and drawings from historic publications. The author has included in the volume brief, accurate, and readable summaries of the main facts dealing with the life histories of the more important contributors to medical literature since the earliest beginnings of medicine.

In this edition a well selected bibliography has been added. This should prove useful to the student or any physician who is desirous of collecting information dealing with the life and work of any of the great medical men of the past. In other words, the book contains all of the material which makes it a most satisfactory reference to consult when initiating a study of a historic nature of an important disease or of a physician.

In selecting the material for the volume the author very wisely has not always limited himself to the very earliest published article dealing with the subject. In many instances the initial contribution is fragmentary, sometimes inaccurate, and surpassed in importance and completeness by subsequent publications, either by the same author or one who was a contemporary or lived some time later. For example, this is true of Addison's first public utterance referring to pernicious anemia which was read before the South London Medical Society in 1849, and appeared in the *London Medical Gazette* for March of that year. This contribution is disappointing as it is vague and tells very little about the disease, nor does it clearly differentiate between pernicious anemia and adrenal insufficiency. Greater attention is devoted to the paper written by Addison in 1855 which is proper, as it contains more detailed and accurate information about the disease.

Considerable space is devoted to the historic case of anemia as described to James Scarth Combe in 1833 as representing an early description of pernicious anemia. A critical perusal of the facts as presented fails to convince one that the patient was suffering from true pernicious anemia, although it is clear that he had a severe anemia of some type or other. The statements that "his face, lips and the whole extent of the surface were a deadly pale colour" and "his tongue was covered with a dry fur" are not in accord with the diagnosis of the disease as we know it now. This description might well be replaced by the classical one of Professor Antone Biermer published in 1872, although a briefer account by him had appeared in 1838. This surpassed Addison's contribution in completeness and accuracy, and directed the attention of the profession in Europe to the disease.

As a medical teacher, I welcome this book in the new and enlarged edition. It should be brought to the attention of every medical student, although often undergraduates are not interested in the subject of medical history. In the opinion of the reviewer, however, this is not always the fault of the student but the lack of enthusiasm for this phase of medical teaching on the part of the teacher. To me, the only scholarly approach to an understanding of any subject in medicine is the study of the development, step by step, in our knowledge. In this way, and in this way only, can a thorough understanding of a disease condition be obtained.

As a teacher, my interest has also been aroused in another matter which is concerned with the history of medicine. Why is it that most students, and many successful physicians, can blunt their intellectual curiosity and professional pride to the point where they can, day after day, use a term such as "Addison's disease" or "Hodgkin's disease" or some other eponym, and never display the slightest inter-

est in ascertaining some information in regard to the man whose name is attached to the condition. In most instances fifteen minutes a day for a short period with Major's book would dispel this ignorance.

Cyrus C. Sturgis

A Textbook of Surgery. By John Homans, M.D., Clinical Professor of Surgery, Emeritus. Sixth edition. Compiled from Lectures and Other Writings of Members of the Surgical Department of the Harvard Medical School. Cloth. Price, $8.00. Pp. 1278, with 530 illustrations. Springfield, Illinois: Charles C Thomas, 1945.

This textbook is familiar to most students who have graduated from medical school since the first edition was published in 1931. In the first edition it was stated that the book was intended to record and amplify the lectures given by members of the surgical department of the Harvard Medical School. The department was fortunate in having Dr. Homans for their historian since he presented their teaching with charm, clarity and interest. It was he who wrote the historical introduction to each subject, and gave the anatomical and physiologic background to every chapter.

The book has been a justly popular one with students of medicine and with practitioners, going through five editions with several reprints before this, the sixth edition. In this edition the names of the original contributors, twenty-two in number, no longer appear although this deletion is explained in the preface. The omission is just since after all the textbook is that of John Homans; his personality of style, individuality of thought, intelligence of arrangement have given the book the characteristics that have made it one of the most popular of texts. In this new edition the book has been brought up to date in every way. As stated in the preface, it is a war edition—"as wars introduce problems and confirm or disprove the worth of many procedures."

In spite of many changes in the text, the original pagination has been preserved through deletion, correction and substitution. The surgical lessons of the war and the progress in civilian laboratory and clinic are fully covered.

The chapter on anesthesia originally derived from an "Outline of Anesthesia" by Dr. Ralph T. Knight has been changed to a more recent form of that guide. In this day of ultra specialization it is questionable whether chapters on gynecology and surgery of the eye are not superfluous. The student of medicine will be required to have other texts on these subjects. On the other hand, it may be that the author is rendering a service to the teaching of surgery when he retains these sections since one must admit that surgical principles are the same in all of the surgical specialties, no matter how convenient these divisions of labor are to those who practice them and how helpful they may be to the patients treated under their auspices. It is hoped that in the next edition Dr. Homans will devote more space to the physiological aspects of shock, burns, infections, and intestinal obstruction, which are so important to the student beginning his study of surgical diseases.

The bibliographical index, a valuable feature of all editions, has been brought up to date, by appropriate omissions and additions. These references to original sources have always been a valuable feature since it offers a historical background to the teaching of surgery. Minor changes in the illustrations have been made, but the original line drawings of Shepard are still vivid and an invaluable part of the book.

Without going into detail it can be stated that the newer advances in surgery from the laboratories of war and peace have been incorporated in this edition. It is one of the most readable and interesting of textbooks, sound in scientific knowledge, written for the undergraduate student of medicine in a style that emphasizes the continuing growth and advancement of the surgical art. It will continue to interest and stimulate students of medicine in the growth, development and latest advancement of surgery, one of the most dramatic and important subjects of their medical school curriculum. To all of them and to their teachers this new edition of a great textbook can be recommended.

Frederick A. Coller

A Bibliography of Visual Literature 1939–1944. Compiled by John F. Fulton, Phebe M. Hoff, and Henrietta T. Perkins. Prepared by the Committee on Aviation Medicine, Division of Medical Sciences, National Research Council, acting for the Committee on Medical Research, Office of Scientific Research and Development, Washington, D. C. Cloth. Price, $3.00. Pp. 117. Springfield, Illinois: Charles C Thomas, 1945.

This classified compilation, originally requested by the British Air Ministry and prepared under the auspices of the National Re-

search Council, deals with literature on vision which might be of military importance on land, sea or in the air. Never before has the eyesight been more important than in the past five years of active warfare. In this time, new aspects of vision have been put to the rigorous tests, among them being the long continued blackout and the increasing speed and heights of airplane flights. With the amazing growth of the literature in these and closely allied fields, it is of great assistance to have made available a comprehensive and critical bibliography of the subject, collected by experienced and competent workers who have provided such a reliable and well classified group of titles.

It has not been possible for them to include all of the aspects of vision as related to military operations, as this in many instances would have carried the project too far afield. Their attention, therefore, has been concentrated on physiology with special reference to night vision, color vision, and perceptual problems. In addition, the literature on methods of visual examination and testing of military personnel has been adequately covered. This is a subject which, of course, is of increasing importance in civilian aviation.

Some indication of the nature of the material which has been included in the volume of 117 pages may be gained from the titles of the nine main divisions under which the subject matter is included. They are: Anatomy and Ophthalmology, Physiology and Psychology, Visual Methods and Testing (including methods and instruments), Correction of Ocular Defects in Military Personnel, Training for Military Specialties (including optimal conditions and procedures, job analysis), Ocular Trauma (in military service), Goggles and Ocular Protection, Illumination, and Visibility. A well worthwhile addition, which should never be omitted in a publication of this sort, is an index of authors and also of subjects.

That the material is collected and presented in an accurate and comprehensive manner is guaranteed by the fact that the publication has been prepared by the authors who had been responsible previously for the Bibliography of Aviation Medicine and its Supplement.

With the amazing growth of medical literature in the past few decades, and there are no important signs of this slackening even with the cessation of the war, there is an imperative need for bibliographies such as these, if the information which is available is to be made accessible. This one, and the previous similar volumes dealing with the subject of aviation medicine, might well be used as a pattern for such compilations.

Cyrus C. Sturgis

BOOKS RECEIVED

The Traumatic Deformities and Disabilities of the Upper Extremity. By Arthur Steindler, M.D., F.A.C.S., Professor and Head of the Department of Orthopedic Surgery, The State University of Iowa. In Collaboration with John Louis Marxer, M.D., Associate, Orthopedic Department, The State University of Iowa. Cloth. Price, $10.00. Pp. 515, with 1048 illustrations. Springfield, Illinois: Charles C Thomas, 1946.

Electron and Nuclear Counters: Theory and Use. By Serge A. Korff, M.A., Ph.D., Associate Professor of Physics and Supervisor of Physics Research, College of Engineering, New York University. Cloth. Price, $3.00. Pp. 212, with illustrations. New York: D. Van Nostrand Company, Inc., 1946.

Journal of the History of Medicine and Allied Sciences. January, 1946, Volume I, Number 1. Pp. 182. Published quarterly. Subscription rate, $7.50 in the U. S., Canada and Latin America; $8.50 elsewhere. Single copies $2.50. Henry Schuman, 20 East 70th St., New York 21, N. Y.

Karolinska Sjukhuset. Redogörelse för Första Etappen av Karolinska Institutets Nybyggnader A Norrbacka Vid Stockholm. Pa byggnadskommitténs uppdrag utarbetad av Th. Borell, Gösta Forssell och Einar Key. Cardboard. Pp. 265, with 60 illustrations and 22 plates of plans and sections. Stockholm, Sweden: P. A. Norstedt & Söner, 1944.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

A CUSTOM MADE FILM IDENTIFICATION MARKER

By WILLIAM S. ALTMAN, M.D.
QUINCY, MASSACHUSETTS

THE accompanying description and diagrams apply to a film identification marker which can be made to suit individual desires and has the following advantages:

1. It can be mounted flush with the dark room bench top.
2. It utilizes the corner of the film.
3. The size of the marker can be varied.
4. An ordinary 3 by 5 inch index card, suitable for other filing purposes, is used (see Fig. 1).
5. It is constructed chiefly from non-critical material.

Figures 2, 3 and 4 are copied from a full scale drawing. In this model the size of the marker is 2 11/16 by 1 1/8 inches, but any size can be used.

By printing the name of the hospital or radiologist eccentrically (see Fig. 1 and 5) the corner of the film can be used.

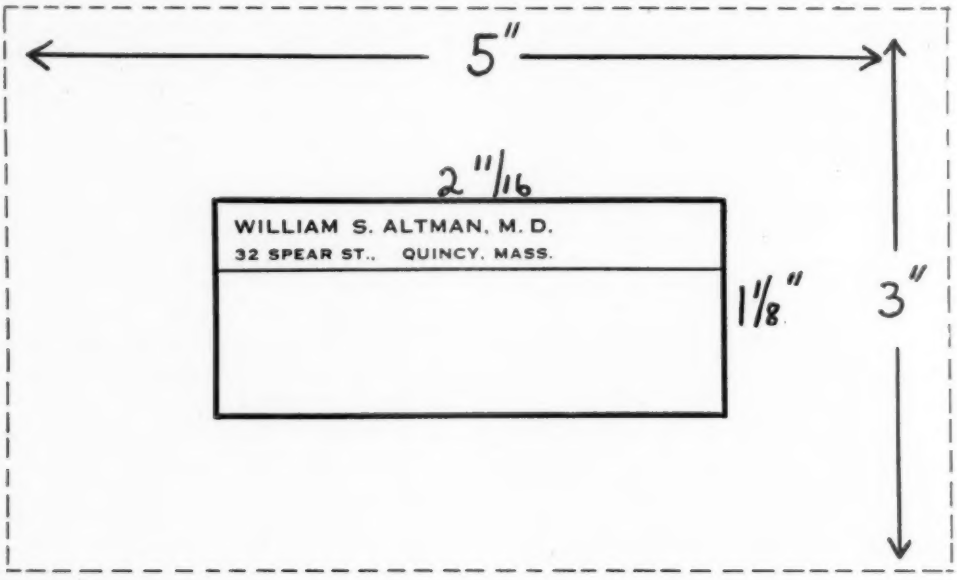

Fig. 1

We have found it most convenient to keep the lead mask in the upper right hand corner of the cassette (when the bakelite side is down and the hinge end at the top). In this way, without turning, the film can be lifted from the cassette and the unexposed portion of the film (protected by the lead mask) can be placed on the marker.

The lead mask can either be recessed inside the cassette or glued on the outside with a household cement.

The switch in Figure 2 is a momentary contact type. A micro-switch can be used. To make the action more automatic a lever

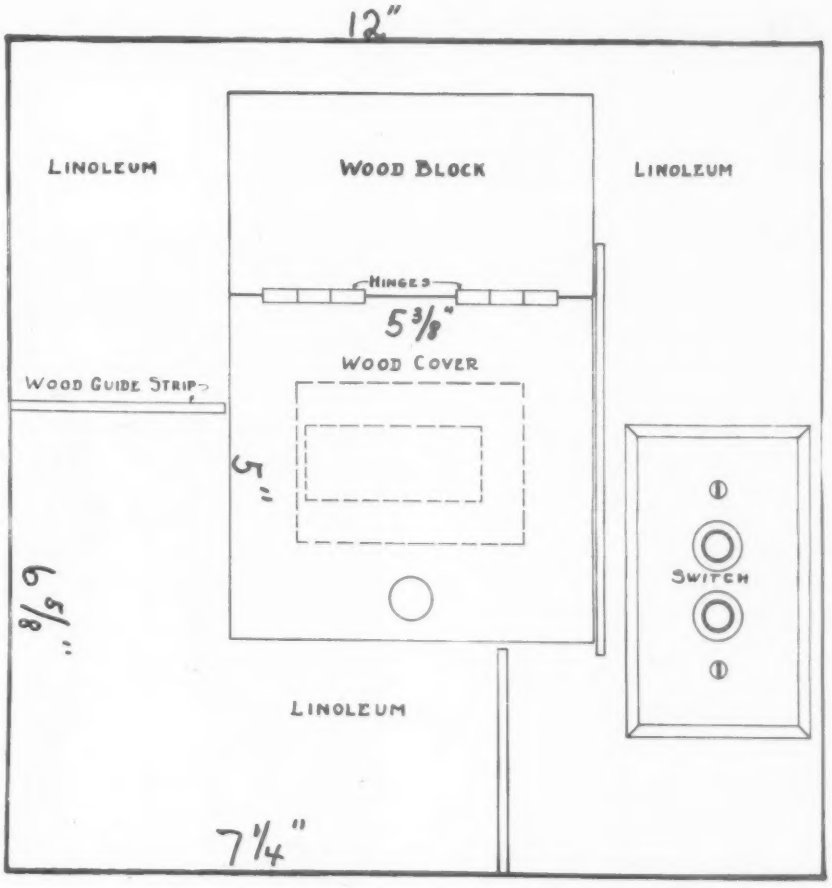
12"
LINOLEUM
WOOD BLOCK
LINOLEUM
HINGES
5 3/8"
WOOD COVER
WOOD GUIDE STRIP
5"
6 5/8"
SWITCH
LINOLEUM
7 1/4"

Fig. 2

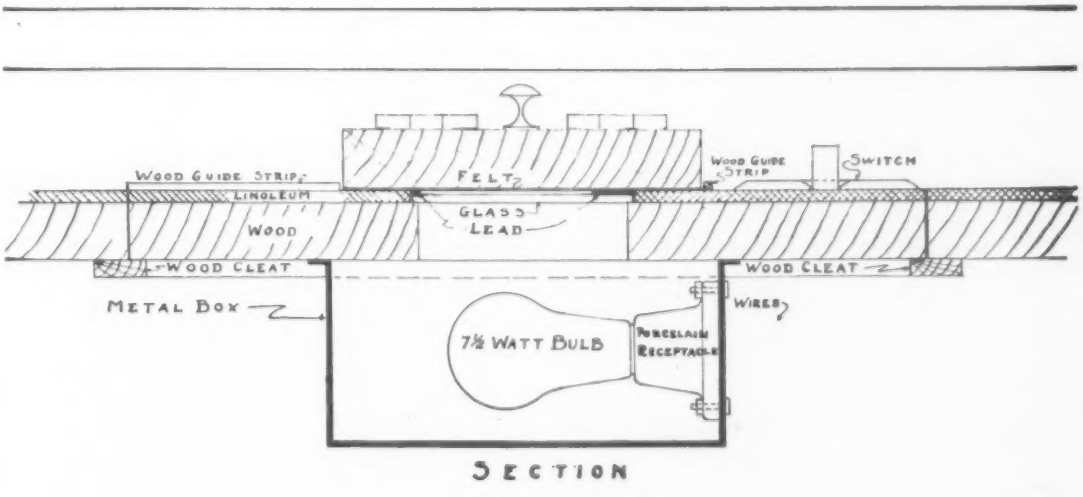
WOOD GUIDE STRIP
LINOLEUM
WOOD
FELT
GLASS
LEAD
WOOD GUIDE STRIP
SWITCH
WOOD CLEAT
WOOD CLEAT
METAL BOX
WIRES
7½ WATT BULB
PORCELAIN RECEPTACLE
SECTION

Fig. 3

from the wood cover to the switch can be added.

A piece of exposed film is used as a filter for the light box. Different densities should be tried. With the correct density only a flash exposure is required for regular film and three to six seconds for no-screen film.

32 Spear St.
Quincy, Mass.

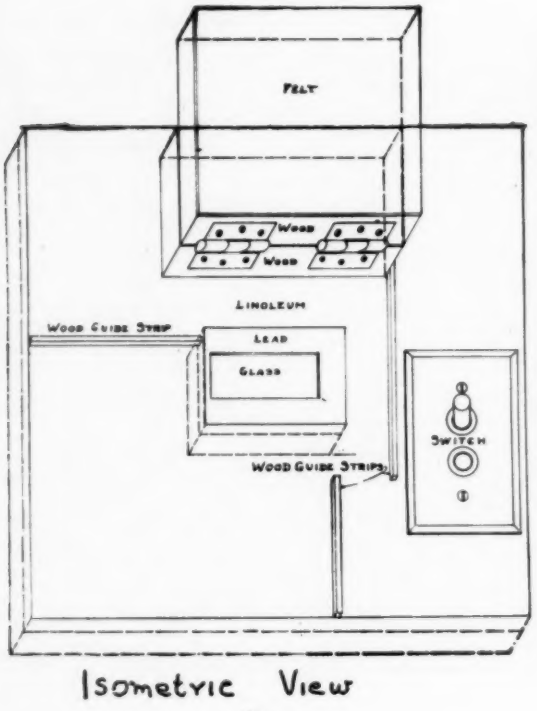

Fig. 4

Fig. 5

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A LAMINAGRAPHIC ATTACHMENT FOR THE UNITED STATES ARMY FIELD ROENTGEN-RAY UNIT*

By LIEUTENANT ROBERT SHAPIRO (MC) USNR
United States Naval Hospital
SAMPSON, NEW YORK

MANY of the Army and Navy hospitals on forward Pacific bases are equipped with the Army Field Roentgen-Ray Unit. Frequently this is the only roentgen apparatus available. At times, laminagraphic studies are quite desirable and helpful. The author, feeling this need during a recent tour of duty in the Pacific, devised a simple laminagraph which adequately served the purpose.

Because the tube and cassette carriage in this unit are synchronized to move in the same direction, it was necessary to construct a separate carriage which moved independently of the tube. This was accomplished by fitting a piece of pipe on each of the four metal pins at the ends of the table. A strip of right angle iron running the length of the table on either side was then welded to the pipe (Fig. 1).

A piece of $\frac{3}{4}$ inch plywood was used for the table top, instead of the usual litter. The plywood was secured on each side by screws to a strip of metal which was welded to the piping at the ends of the table, above the angle iron for the carriage. On the angle iron runners was placed a cassette carriage (made out of scrap galvanized tin), riding on four ball-bearing wheels (Fig. 3*a*, 3*b* and 3*c*). The carriage was designed to hold a cassette of any size and a stationary Lysholm grid (no movable

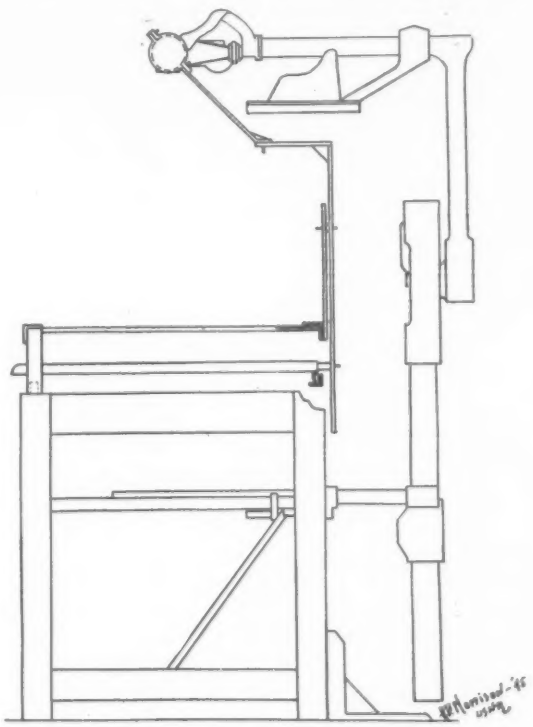

FIG. 1. End view of roentgenographic table with laminagraph in situ.

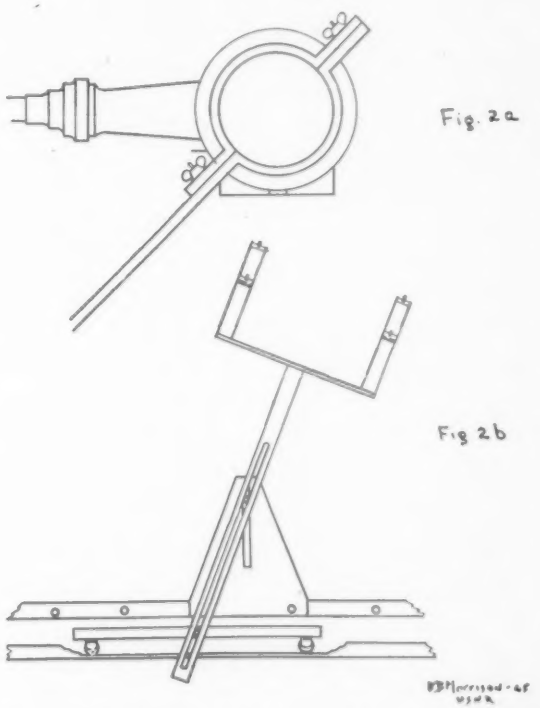

FIG. 2*a*. End view of laminagraphic attachment to roentgen-ray tube head. 2*b*. Front view of laminagraphic attachment to table.

* The opinions set forth in this paper are those of the author and do not necessarily reflect the views of the Navy Department.

Potter-Bucky diaphragm was available). Holes 12 inches apart were drilled in the sides of the metal strips securing the plywood table top (Fig. 2*b*). This permitted the laminagraph to be fastened to any part of the table, thus making it possible to study various anatomical parts conveniently.

A metal plate with a vertical slot was screwed into the holes on the side of the table. To this plate by means of screws and wing bolts the vertical component of the laminagraph was attached. The latter was then connected to the tube at one end and the cassette carriage at the other end. The connection to the carriage was made by means of a screw welded to the side of the carriage, and a wing bolt. The attachment to the tube was accomplished by bipartite metal collars, fashioned to fit around the ends of the tube (Fig. 2*a*). It was necessary to angulate the vertical rod in order to clear the roentgenoscopic shutter. By moving the vertical arm to which the tube is attached the tube and carriage are made to travel in opposite directions about an axis adjustable as to height.

With a little practice, good laminagrams can be obtained with this simple device.

103 Pembroke St.
Hartford, Conn.

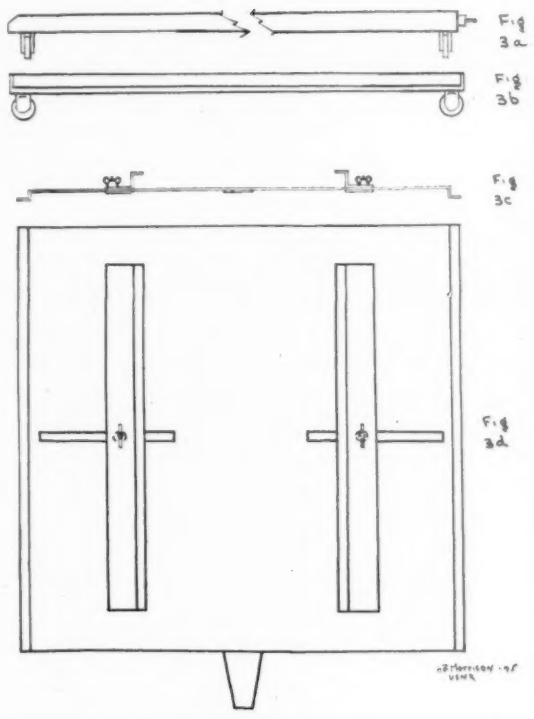

FIG. 3. Carriage and cassette holder. *a*, end view of carriage; *b*, front view of carriage and cassette holder; *c*, end view of cassette holder; *d*, top view of cassette holder.

The author wishes to express his grateful appreciation to H. B. Morrison, CPHM, W. R. Howard, PHM1/c and J. T. Conneley MM1/c for their invaluable assistance.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

Eddy, C. E. The development of centralized radon services in Australia. *Radiology*, Aug., 1944, *43*, 155–169.

The use of radon has decreased in a number of countries. But it seems possible that the unsatisfactory results obtained with it have been due to unsatisfactory methods of use rather than to any disadvantages in the radon itself.

A National Radium Scheme was inaugurated in Australia in 1928 and provision made for radon to be made available. Radon centers were established in Melbourne, Sydney, Adelaide, Perth and Brisbane. Radon is issued only to hospitals that have radiotherapists who are experienced in its use. A table is given showing the total number of millicuries used for treatment purposes by these various centers. Experience has shown that radon supplied by a centralized radon service has advantages over the use of radium under some circumstances. Moreover, a centralized service can supply a hospital with the necessary amount of radon at any time.

The radon is placed in gold capillary tubes and the screening and length and strength of the tubes adapted to a wide variety of situations and uses. A case is described in which a large cancer of the breast was successfully treated by the use of radon needles of a large variety of lengths and strengths. A practically uniform irradiation field and the desired dosage distribution can be obtained in this way. Permanent implants can be used in many sites where the use of temporarily inserted needles is contraindicated.

A physical method of purifying radon has been substituted at these centers for the older chemical method. It reduces the time required for purification to one-half, the exposure of the operator to one-fifth and the final purity of the radon is considerably increased.—*Audrey G. Morgan.*

Munson, Frederick T., and Munson, Henry T. X-ray treatment of sinusitis. *Am. J. Surg.*, July, 1944, *65*, 95–97.

The authors present a general summary of their experience as otolaryngologists in the use of roentgen therapy for the treatment of acute and chronic sinusitis. In their experience relief of symptoms is much more dramatic in the former. They believe the effect in acute cases is due to a combination of diminution of cellular infiltration by selective action of the rays on leukocytes and to improved drainage by increased vascular supply. These factors diminish the thickening of mucous membrane and so reduce tension on nerve fibrils. In chronic forms they have been less successful in obtaining relief from symptoms. In such cases as do obtain benefit they believe the action is due to scarring and diminution of thickness of mucous membrane, thus reducing congestion about the natural sinus ostium and permitting more adequate drainage. Their results have been poor in chronic suppurative cases and in those with marked polypoid degeneration. Factors used in roentgen treatment were 150 kv. (peak), 15 ma., 50 cm. target-skin distance, filter 0.25 mm. Cu plus 1.0 mm. Al. Treatments, in doses of 100 to 150 r, were given every two to six days, on an average of every three days.

Of a series of 20 cases of acute sinusitis, 11 were relieved of pain after one treatment, 4 required three treatments, 3 required five to six treatments and the remaining 2 were subjected to sinus puncture after one treatment.

They believe the method not entirely free from danger of (*a*) damage to the pituitary gland, (*b*) permanent alteration of the normal physiological anatomy of the nasal mucosa and (*c*) cumulative effects of the rays which might complicate treatment at a future date. Chief advantages cited are early relief of pain in "most all cases" and lack of discomfort in the mode of treatment.—*Angus K. Wilson.*

Christensen, F. C. Roentgen therapy of sinusitis, with special adapter. *Radiology*, July, 1944, *43*, 21–29.

The importance of sinus infection, especially

in children, is shown by the fact that in autopsies on 495 children 30 per cent were found to have suppurative sinusitis.

Fluoroscopic examination is of great value in the diagnosis of sinusitis. Roentgen treatment is very effective in properly selected cases. A brief review of the roentgen treatment is given. The usual method of treating each sinus through a small cone requires a great deal of time and the depth dose is decreased. The author therefore devised a 25 cm. cone with an adequate and proper filter at the end of it so arranged that the eyes are screened and all the sinuses are given radiation at a focal distance of 40 cm., no other parts but the sinuses being exposed. Photographs of the cone are given and of patients in position for treatment with it. A better depth dose is obtained with this cone than with the small cones usually used.

The author has used this device in 29 cases of subacute and chronic sinusitis. Three of them are described in detail, 2 because of complications and 1 because a single mild treatment gave complete and permanent relief. All of the patients had had severe headache which in all cases was relieved by the roentgen treatments. No patient was given more than four treatments nor more than 450 r. The average number of treatments per case was three and the one patient mentioned above was given only a single dose of 80 r.—*Audrey G. Morgan.*

Buschke, Franz, and Cantril, Simeon T. Supervoltage roentgen therapy of esophageal carcinoma. *Radiology*, May, 1944, *42*, 480–492.

This report from the Tumor Institute of the Swedish Hospital, Seattle, Washington, considers the treatment of only epidermoid carcinomas of the thoracic portion of the esophagus. Since 1939 the authors have treated these tumors with an 800 kv. apparatus. Experience with a 200 kv. apparatus before that time has shown that it is practically impossible to give an adequate tumor dose in this location with 200 kv. irradiation. The average sterilizing dose is 5,000 r delivered within four to five weeks. The depth dose with this kilovoltage is such that an adequate tumor dose cannot be delivered in this time without injury to the skin. It cannot be delivered through anterior and posterior fields alone and so large oblique or lateral fields have to be used with increased injury to the skin and the general health.

With 800 kv. radiation of the type they have used the depth dose at 10.5 cm. is 50.8 per cent and at 11.5 cm. it is 44 per cent. With this type of radiation the skin can easily tolerate 5,000 r in a period of four to five weeks and a sufficient dosage can usually be given through anterior and posterior fields alone. If the use of oblique fields is necessary, a localizer has been devised, consisting of a wooden arch, which is illustrated. With its use exactly the same position can be used every day.

The 5 cases treated by this method are described and illustrated with roentgenograms. One patient is free of roentgen evidence of recurrence after three and a half years. The others are all dead. These cases are inadequate for judgment of the method but they are reported for the purpose of discussing technical problems and encouraging others to make similar reports. For successful use of this method the patient must be free of lymph node metastases, be in sufficiently good general condition to stand so severe a treatment and must be in a hospital where he can be under constant clinical observation.—*Audrey G. Morgan.*

Ashbury, Howard Hicks. Radiation therapy of lymphoid tissue in the nasopharynx and pharynx. *Radiology*, Sept., 1944, *43*, 250–253.

During the five year period from 1939 to 1943 inclusive, 157 patients were treated for the removal of lymphoid tissue in the nasopharynx and pharynx with roentgen rays, later associated with gamma rays. Approximately one-third of the patients were less than fifteen years of age. The patients were classified from one to four plus on the basis of the amount of lymphoid tissue present. In the three plus cases there was enough lymphoid tissue to cause mouth breathing, and in the four plus cases the tonsils met in the midline or the nasopharynx was so choked with lymphoid tissue that little or no air space remained. Twenty-three per cent of the cases were 3 plus and 10 per cent 4 plus.

The first cases were treated very conservatively as there is rarely need for the production of erythema. A dose of from 800 to 1,200 tissue roentgens was given in four to five weeks. This was very satisfactory for young children but for older children and adults it was not sufficient. So 25 mg. radium was introduced into each nostril with an applicator, filtered with 1 mm. platinum; in an hour and a half 75 mg-hr. was

delivered and this is used as the standard dose. No unfavorable reactions were seen with this amount and the roentgen dose could be reduced and better results obtained. A table of the cases treated in this way is given and it shows that only 8 out of 62 patients required more than 1,000 tissue roentgens.

Two cases illustrating the successful use of this method in the treatment of conduction deafness in children are described and 2 showing equally good results in children with respiratory obstruction and infection. The method was also used successfully for chronic suppurative tonsillitis in old people in whom surgery was contraindicated by heart disease.—*Audrey G. Morgan.*

HAWLEY, SYDNEY J. Roentgen treatment of lymphoid tissue in the nasopharynx. *Radiology*, Sept., 1944, *43*, 254–255.

Excessive lymphoid tissue in the nasopharynx is common in infancy and childhood and if allowed to go untreated may cause deafness. If treated early hearing may return to normal. Surgical removal of adenoids around the eustachian tubes is difficult and they can be treated successfully with roentgen rays. A dose of 700 to 800 tissue roentgens given on each lateral wall of the nasopharynx within eight days has given successful results in the 26 cases discussed. There was recurrence in only 2 cases.

Two direct lateral fields were used centering over the nasopharynx. The factors were 200 kv., 0.5 mm. copper plus 1.0 mm. aluminum filter with a half-value layer of 0.8 mm. copper. There were no unfavorable reactions. The lymphoid tissue disappeared in every case and in 17 cases there was improvement in hearing as measured with an audiometer. Audiograms from a typical case before and six weeks after treatment are given.—*Audrey G. Morgan.*

COOPER, GEORGE, JR., and ARCHER, VINCENT W. Neurosurgery and radiation for the relief of pain in advanced cancer. *Radiology*, Aug., 1944, *43*, 142–146.

It is a mistake to give a patient with advanced cancer or metastases over to opiates and allow him to die or become a drug addict. The responsibility of the roentgenologist is very great in these cases for pain can be relieved and the patient's life made more liveable and in many cases life can be prolonged, sometimes for years. Seven illustrative cases are described in which life was greatly prolonged, in one case for ten years and the patient is still living and able to do his work as a carpenter. This patient was a man of sixty-three when operated on for cancer of the testicle. After two years a cancer metastasis developed behind the right eye. Irradiation brought relief and normal vision but later a cataract developed in the eye.

Another aid in controlling pain in advanced cancer is neurosurgery. Dramatic relief is often afforded by nerve injections, root sections and chordotomies. The roentgenologist should consult the neurosurgeon if he thinks there is any chance of help from him. These operations of course involve a certain amount of risk of causing loss of sensation, loss of sphincter control or paralysis and they should not be undertaken unless the endurance of the pain from cancer is harder than the complications that may result from operation.—*Audrey G. Morgan.*

MANSUR, EDWARD E. The ureter and its involvement in pelvic irradiation. *Radiology*, Aug., 1944, *43*, 147–154.

Attention is called to the vital importance of the ureter and the frequency with which it is injured in irradiation, particularly of cancer of the cervix. Roentgenograms are given of the female pelvis with ureteral catheter and cervical disk and pessary in place, showing how close the ureter lies to the cervix and how easily it is injured in irradiation. Unfortunately, though these anatomical facts are known it seems to be rare for the necessary precautions against injuring the ureter to be taken and for the roentgenologist to follow up the case for the time necessary to prevent damage.

Often the ureters are compressed by the growing tumor before treatment and the ureter is apt to be caught in the healing fibrosis after irradiation. Damage of the ureter is much more frequent in irradiation of cancer of the cervix than damage of the bladder or bowel, but much less attention is paid to it.

It should be remembered that the ureter can be kept open but it cannot be opened up after it has been allowed to become too small for a No. 6 catheter to pass. The technique for keeping the ureter open, including pyelography and cystoscopy, leaving one catheter in place for a time, is described in detail. Usually an opiate hypodermically is needed after cystoscopy. Sulfathiazole 15 gr. three times a day and a

few sedative tablets are given as a matter of routine. The sulfathiazole has prevented infection in all the author's cases. The cystoscopy is repeated and ureteral calibration is repeated after intervals of four weeks, six weeks, eight weeks, three months and finally at the end of a year if things seem to be going well. The physician should not wait for symptoms of block of the ureter to appear before doing something to prevent it, for often the condition is symptomless until uremia has developed and it is too late to save the patient's life.

The mortality for cancer of the cervix can be reduced by taking these precautions in regard to the ureter.—*Audrey G. Morgan*

Howes, Wm. E. Castration for advanced malignant growth: Short review with a case report. *Radiology*, Sept., 1944, *43*, 272–274.

The history of castration in the treatment of advanced malignant tumors is reviewed. It seems to have been demonstrated that castration is of value in the treatment of malignant growths of the breast and prostate. In 1943 Herbst reported improvement in a case of malignant melanoma of the choroid with metastases after orchiectomy.

The author describes a case in a man of forty-seven treated at the Brooklyn Cancer Institute. On Jan. 31, 1942, the patient had had an exenteration of the orbit performed at another hospital and the pathological report showed a melanoma of the left caruncle and conjunctiva. He remained well for about a year when numerous metastases appeared in the roof of the orbit, on the skin, in both hilar nodes and in the pleurae. Orchiectomy was performed on April 26, 1943. The patient died on June 24 and nothing in the gross or microscopic findings suggested that the orchiectomy had had any effect on the course of the disease.

It is not considered advisable to perform orchiectomy for malignant growths except those with the primary lesion in the breast or prostate.—*Audrey G. Morgan.*

Bischoff, Fritz, Ullmann, Henry J., and Ingraham, Louise P. The influence of irradiation of the ovaries upon estrus and neoplastic development in Marsh-Buffalo mice. *Radiology*, July, 1944, *43*, 55–58.

It has been found that the Marsh-Buffalo strain of mice are resistant to increased incidence of carcinoma of the breast by non-toxic doses of estrins or by stimulation of the ovary with gonadotropins. Experiments were therefore made to determine whether such increased incidence of carcinoma of the breast could be brought about by irradiation. Two groups of 40 mice each were irradiated and equal numbers of litter males used as controls. One group was irradiated with 200 r and 1 with 400 r. Tables are given showing the details of the results.

The 200 r dose reduced estrus markedly; there was in increase in the fourth month, followed by a period of six months in which the estrus was practically the same as that of the controls. The incidence of adenocarcinoma of the breast was increased markedly but the incidence of lymphoid tumors was not increased. There was no correlation between the extent of estrus and tumor development. The 400 r dose abolished estrus entirely immediately after irradiation, and estrus never came up to that of the controls during a period of thirteen months. It did not increase the incidence of cancer of the breast but did increase that of lymphoid tumors. In these experiments the uterus, mammary glands and head were shielded from irradiation but the adrenals must have received a considerable dose and it is possible that this played a part in the results.—*Audrey G. Morgan.*

Erskine, Arthur W. The evolution of an improved transvaginal speculum. *Radiology*, Aug., 1944, *43*, 170–174.

The author describes and illustrates a series of transvaginal specula which he worked out in an effort to secure the best possible application of roentgen rays directly through the vagina to cancers of the cervix. The last one which most nearly meets the requirements of even exposure of a sufficiently large oval or oblong field, good visibility, comfort, an anode-surface distance of not more than 30 cm., rigidity, simplicity and cheapness and protection of the vulva, is an expanding blade speculum which, when the two blades are expanded, assumes the shape of an oblong truncated pyramid with rounded corners. Two sizes are enough for the great majority of patients. The larger, the greatest circumference of which is 14.5 cm., exposes a field 5×6.5 cm. The smaller, the circumference of which is 13 cm., exposes a field 3.75×5.25 cm. Graphs are given showing the distribution of the rays through the large and small specula. According to these figures an aggregate dose of

6,000 r can be delivered to the tissues at a depth of 3 cm. without causing necrosis of the part of the cervix nearest the tube.

The possibility of treating cancer of the cervix by transcervical irradiation alone without the long, trying and expensive series of external cross-fire treatments is discussed.—*Audrey G. Morgan.*

McCormick, Norman A. Cancer of the rectum. *Radiology*, June, 1944, *42*, 531–538.

Cancer of the rectum, contrary to general opinion, is one of the most readily curable forms of malignant growth. It causes definite symptoms early and is readily accessible to examination so it should be possible to make an early diagnosis. The five year survival rate is higher than in most malignant growths.

The best palliative treatment is roentgen irradiation 200 kv., 50 cm. distance, through anterior and posterior fields 10×15 cm., minimum filtration 1 mm. copper and 3 mm. aluminum; 200 r per day to each field to a total of 2,000 r. Of the author's patients treated by irradiation alone, 58 per cent have not required colostomy. Radium is not used in the palliative treatment of this form of cancer in his service (Metropolitan General Hospital, Windsor, Canada).

The curative treatment of cancer of the rectum is abdominoperineal resection. No less radical form of operation is effective. Colostomy should not be performed unless obstruction has occurred or is impending. And it should not be performed unless the tumor is removed. With a colostomy without removal of the tumor, the patient is more miserable than before while with a colostomy following abdominoperineal resection he can live a useful and practically unrestricted life. The same roentgen treatment as for palliation should be given before operation. The author's operative mortality in the last 23 cases has been only 9 per cent and he believes that in general with modern methods and careful technique it can be kept down to 10 per cent. He has not had time to judge permanent results but Leahy reports 40 per cent five year survival. The five year survival after radical mastectomy is only 25 per cent.

In cases that are operable theoretically but cannot be operated on on account of heart disease or for other reasons, radical irradiation may be used—2.5 mm. copper filtration at a distance of 80 cm., with a larger total dosage than is used for palliation or preoperatively. This may be supplemented by implantation of radium needles or radon. This treatment should be recommended only after very serious consideration.—*Audrey G. Morgan.*

Reeves, Robert J. Radiation treatment of ganglia of the wrist. *South. M. J.*, Oct., 1944, *37*, 584–586.

The author reports his experience with roentgen treatment of 15 cases of ganglia of the wrist and fingers which had been followed for more than a year following completion of therapy. In this series there were only two recurrences, giving a rate of cure of 87 per cent. Factors employed in treatment were 200 kv. (peak), 0.5 mm. copper filter, half-value layer 1.1 mm. copper. Lesions less than 1 cm. in diameter were given 500 r at one sitting, without preliminary aspiration; ganglia greater than 1 cm. in diameter were given 400 r immediately after aspiration of fluid content. These doses were repeated at monthly intervals if the tumor persisted; it was not found necessary to give more than three treatments in any case. The author recommends roentgen treatment given according to this plan since the results are at least equal to those obtained by surgery, the cosmetic results are better and hospitalization is unnecessary—*Angus K. Wilson.*